RADIOLOGICAL ASSESSMENT OF INTER-PROSTHETIC JOINT MOVEMENT IN BIPOLAR HIP HEMIARTHOPLASTY FOR FRACTURE NECK OF FEMUR

By

DR. S. KAILASH M. B. B. S

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Under the guidance of

Dr. V. SHYAM SUNDAR, M.S. (ORTHO) ,

Professor

DEPARTMENT OF ORTHOPAEDICS,

PSG INSTITUTE OF MEDICAL SCIENCES AND RESEARCH

COIMBATORE

2014

<u>DECLARATION BY THE CANDIDATE</u>

I hereby declare that this dissertation entitled **"RADIOLOGICAL ASSESSMENT OF INTER-PROSTHETIC JOINT MOVEMENT IN BIPOLAR HIP HEMIARTHOPLASTY FOR FRACTURE NECK OF FEMUR"** is a bonafide and genuine research work carried by me under the guidance of **Dr. V. SHYAM SUNDAR, M.S Ortho,** Professor, Department of Orthopaedics, PSGIMS & R, Coimbatore.

Place:

Date: **Dr. S. Kailash**

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled **"RADIOLOGICAL ASSESSMENT OF INTER-PROSTHETIC JOINT MOVEMENT IN BIPOLAR HIP HEMIARTHOPLASTY FOR FRACTURE NECK OF FEMUR"**is a bonafide work done by **Dr. SOUNDARA RAJAN KAILASH** in partial fulfilment of the requirement for the degree of M.S. (Orthopaedics).

Place

Date

Dr.V. Shyam Sundar

M.S. (Ortho)

Professor

Department of Orthopaedics

PSGIMS & R

Coimbatore.

PSG Institute of Medical Sciences & Research
Institutional Human Ethics Committee

POST BOX NO. 1674, PEELAMEDU, COIMBATORE 641 004, TAMIL NADU, INDIA
Phone : 91 422 - 2598822, 2570170, Fax : 91 422 - 2594400, Email : psgethics2005@yahoo.co.in

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Institution	:	PSGIMS & R
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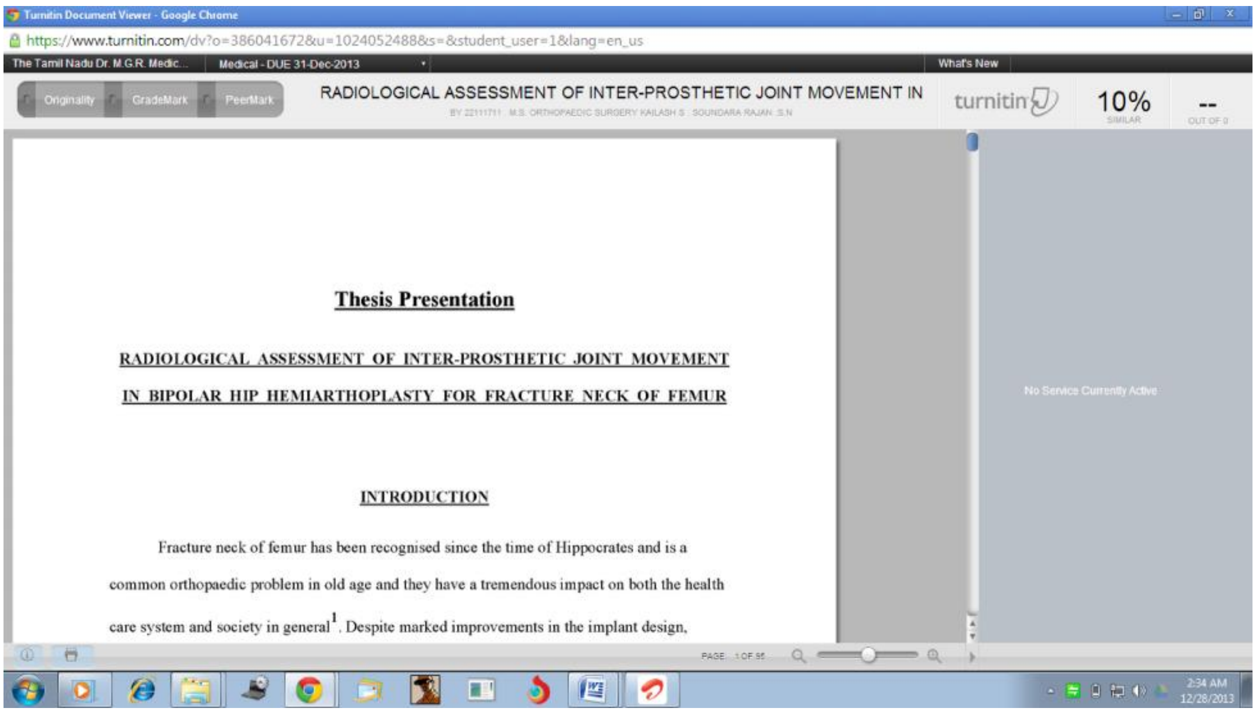

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ABSTRACT

Introduction:

Bipolar prosthesis was designed to allow movement in 2 planes ie between acetabulum & outer bearing s & Prosthetic femoral & inner bearing. Hence universal movement takes place at the inter-prosthetic joint (IPJ). Over a variable period of time the bipolar prosthesis becomes unipolar functionally due to stiffening up of inter-prosthetic joint. This study is mainly done to assess the inter-prosthetic joint movement in bipolar prosthesis done for fracture neck of femur at 6months & mid-term follow-up.

Materials & Methods:

It's a 2 part study:

Part 1: Included 30 patients who have undergone Bipolar Hemi-arthroplasty for Fracture neck of femur from the period of December 2011 to June 2013. These patients were followed up prospectively with Radiographs at immediate, 6 weeks & 6 months of post-operative period. & IPJ motion was assessed.

Part 2: Retrospectively we called 10 patients who had undergone Bipolar H.A 2 years/ or more & repeated the same x-rays. With this we were able to assess IPJ motion at midterm follow-up.

Results:

In prospective follow-up we appreciated about 28 % of the IPJ motion was preserved . In part 2, about 31 % of IPJ motion was found to be still preserved in these patients. The Oxford hip scores was found to be better in patient's with good amount of IPJ motion.

Conclusion:

For effective functioning of bipolar prosthesis IPJ movement remains a vital cog in the success of the bipolar prosthesis. In our study we found that good amount of IPJ motion was preserved at 6 months & at mid-term follow-up & functional outcome was also better in patients with IPJ motion > 25%.

INTRODUCTION

INTRODUCTION

Fracture neck of femur has been recognised since the time of Hippocrates and is a common orthopaedic problem in old age and they have a tremendous impact on both the health care system and society in general[1]. Despite marked improvements in the implant design, surgical technique and patient care, they still remain an unsolved fracture as for as treatment and results are concerned among the orthopaedic fraternity around the world [2]. Fractures of the neck of femur are on increase, which is not unexpected, as the general life expectancy has significantly increased during the few decades. These fractures may double within next 20 years and fracture rate doubles for each decade of life after 5th decade of life[3]. It's has been predicted that by the year of 2050, the number of hip fractures would triple.

This is the commonest fracture in old aged individuals because of osteoporosis and advancing age causing more brittleness of bone. So prolonged immobilization during such fractures in elderly will jeopardise the life span of the patient and further complicates the problem. This forces one to totally abandon complete immobilisation to achieve a bony union, or to resort early ambulatory procedures by surgery.

The blood supply to neck and head of femur is extensive, intricate and complicated. Healing process mainly depends on good blood supply. Non-union, Avascular necrosis of femoral head and secondary degenerative arthritis are the principal complications of this fracture. The surgeon may have control over the problem of non-union, whereas he may have none over Avascular necrosis and arthritis. This further handicaps the treatment of these fractures as the healing process is always in doubt. It's also a known fact that hip is a weight bearing joint and many performance based functions depend on hip joint. A successful operation at hip joint should provide painless, stable hip with wide range of movements. Under these circumstances one has to decide whether the prolonged immobilization has to be employed to achieve bony union or quick ambulation by hemi-replacement arthroplasty, to achieve fair degree of function.

Since early 1950's prosthetic replacement was introduced for solving the problems of fracture neck of femur and vitallium intramedullary prosthesis received a hearty welcome., thus preventing Non-union and avascular necrosis. The Austin – Moore and Thompson prostheses have been successful implants in treating fracture neck of femur. Disabling pain and acetabular erosions are frequent complications after the use of Moore prosthesis [4]. So in an attempt to retard the acetabular wear, prolong the life of the implant and delay the need for revision surgery the Bipolar prosthesis was developed by James E Bateman in Toronto in 1974, which had the great advantage of second joint, below the acetabulum. It was named bipolar prosthesis, since it had an outer head of metal which articulates with acetabulum and a second inner metallic head which articulates with High Density Poly-Ethylene (HDPE) , lining the inner surface of outer head. So theoriatically hip motion is to occur at 2 interfaces – primarily at the prosthetic interface and secondarily at the metal – cartilage interface, thus minimising the articular wear. This prosthesis was found to be very useful and results were encouraging [5].

But studies attempting to demonstrate the relative movements at the interfaces have yielded conflicting results. It's known that a friction produces particulate debris from the polyethylene liner and this was thought to be the casue of foreign body reaction causing stiffening up of the inter-prosthetic joint and also osteolysis and aseptic loosening of the implant.

Recent studies have shown that over a variable period of time the bipolar prosthesis will become unipolar functionally due to stiffening up of the inter-prosthetic joint (IPJ).

This study represents the assessment of the inter-prosthetic joint movement in bipolar prosthesis done for fracture neck of femur at 6months and mid-term follow-up by radiological means. By this study we will be able to assess whether Bipolar prosthesis really functions as it's name suggests or vice versa as the literature suggests.

AIM & OBJECTIVES

<u>AIM</u>

Radiological assessment of the inter-prosthetic joint movement in bipolar hemiarthroplasty done for fracture neck of femur patient's.

<u>OBJECTIVES</u>

1. **Assessment of Inter – prosthetic joint movement in Bipolar prosthesis by radiological means.**

2. **Co-relating the inter-prosthetic joint motion with functional outcome of Bipolar prosthesis using Oxford hip score.**

REVIEW OF LITERATURE

REVIEW OF LITERATURE

A) Historical Review :

Femoral neck fractures has been since the time of Hippocrates (460 – 377 BC) .The first description of hip fractures was by the French surgeon Ambroise pare in 1564 [6]. However he did not clearly distinguish between a fracture and dislocation of hip. Sir Ashley Cooper gave a clear description of fracture neck of femur, other fractures and dislocations around hip [6]. In 1822 in his book titled ' A treatise on dislocations and fractures of joints' he has clearly delineated the differences between intra-capsular and extra-capsular fractures. He believed that non-union of intra-capsular fractures was due to loss of blood supply to the proximal fragment and most femoral neck fractures would eventually heal with a fibrous union and that such patient's would suffer 'permanent lameness' [7,8].

In 1838, the internal trabaecular pattern of femoral head and neck was described by Ward [9,10,11]. Vascular anatomy of femoral head was described by Crock [12]. Mechanism of injury was suggested by Kocher [1]. He also advocated excision of head as intra-capsular fractures would fail to unite.

In 1866, Hamilton and Stimson explained the preferential treatment of internal fixation for fracture neck of femur, quoting surgeries performed by John Ray Burton in Philadelphia in 1834[7]. In 1867, Philips introduced a technique for longitudinal and lateral traction to be used in the treatment of femoral neck fractures to eliminate 'shortening or other deformity' [7]. In 1876, Maxwell reported successful use of this technique. In 1883, Nicholas Senn advocated closed reduction, impaction of fragments and supplemented with internal fixation which would cause union of the fracture [13]. According to Senn ‘ the only cause for non-union in case of intra-capsular fracture is our ability to maintain Impaction and immobilization of fragments during the time required for the union to take place’. Nearly 100 years later, the successful treatment of femoral neck fractures are still dependent on these principles.

Whiteman and Leadbetter methods of closed reduction were important contributions to conservative management [14]. In 1902, whiteman advocated careful closed reduction under x-ray control followed by hip spica application. This produced a few satisfactory unions, but extremely high morbidity and mortality. In 1908, Davis reported the use of ordinary wood screws for fixation of femoral neck fractures [14]. Similar screws were used by Dacosta in 1907, Delbet in 1919 and Martin and Knight in 1920 [15]. The use of autogenous bone peg graft as a method of internal fixation was popularized in America by Albee in 1911 [16]. But frequently bone peg graft was broken and nonunion developed.

Hey Groves in 1916 designed a quadriflanged nail to obtain better fixation but failed because of unsatisfactory material [16]. The first effective method of internal fixation was introduced in 1931 by Smith Peterson and associates [17]. The triflanged nail now bears his name as S.P Nail. When properly used it succeeds in preventing the rotation and with improved alloy constituted in the nail does not produce any tissue reaction. A side plate was added to the triflanged nail by Thornton in 1937. This ultimately led to the development of solid nail plate by by jewett in 1941. Moore (1934) enlarged upon the multiple pin principle of Martin and starting with three pins gradually increased to five [18]. Knowels (1936) advocated threaded pins placed as far apart as possible in the head in an effort to obtain 'Absolute fixation' [19]. In 1945, Virgin and MacAusland introduced Dynamic compression Hip Screw (DHS). Inspite of various method of internal fixation, Brown and Abram [20] (1964) noticed a segmental collapse of femoral head in almost 1/3rd of the displaced transcervical fracture in which there was bony union. The complications occurred only where there was a total necrosis of the capital fragment and no appreciable contribution to revascularization from the arteries of ligamentum teres. Different methods of treatment of femoral neck fracture depending on the type of fracture and age of the patient are:

i) **Osteosynthesis**: A successful osteosynthesis is most satisfactory of all operations of freacture neck of femur whether fresh or old ununited [1,21]. In osteosynthesis, anatomical reduction and rigid internal fixation with or without bone grafting is done. This is usually done in younger age group patients with fracture neck of femur.

ii) **Osteotomy** : To obtain compression force at the fracture site resulting in possible union in ununited fracture femoral neck fractures in younger age [1,21]. The following procedures are done: 1) Mc Murray's osteotomy 2) Dickson's osteotomy, 3) pauwel's Y-osteotomy.

No matter how carefully these are nailed and stabilized, the procedure has got a failure rate of 33 %. Among 2/3 of cases that healed, there's a possibility of avascular necrosis and degenerative arthritis particularly in older people which results in a painful hip.

iii) **Hemiarthroplasty of Hip**: It's dissatisfaction of many surgeons with above mentioned methods of treatment in older people that lead to the trial of hip prosthesis as a final procedure in reestabilishing a painless, functional and stable hip, thereby escaping the uncertainty of bony union and late onset of osteoarthritis. The rationale of this procedure is based on the observation that the hip functions fairly satisfactorily, following salvage procedure in which an endoprosthesis has been used for various pathological conditions.

Evolution of Prosthetic replacement:

To create a new joint by interposing a durable substance between the bone ends is an old idea (Aufranc) [22]. Many different materials have been used like ivory, silver, gold, tin, steel, synthetic materials like plastic, acrylic H.D.P.E etc. Hey groove's replaced a femoral head ivory in 1923 and four years later reported that patient lead an active life [16]. Starting with Glass (Smith Peterson 1925) did work in mould arthroplasty. The mould went through several stages in evolution both in shape and material used. Vitallium became the final choice through a trail and error process [23]. Smith Peterson in 1938 used first vitallium mould arthroplasty in the hip in case of bony ankylosis as result of rheumatoid arthritis [23].

In 1940, Bohlman and Austin T Moore replaced the proximal femur of a patient with recuurent giant cell tumour using a custom made vitallium prosthesis [23, 24]. At post-mortem, bone was found to have grown around and through the holes in the metallic prosthesis. This gave Moore the idea for a femoral head replacement which he later developed . Philip Wiles at the Middlesex hospital in London 1938 used stainless steel for a total hip replacement. McKee in 1940 at Norwich used brass and stainless steel for replacement [24].

The Judet brothers introduced acrylic femoral head for the treatment of osteoarthritis in 1954 [24, 25]. Furthermore in short stem prosthesis, great stress was put upon the bone, within which it comes into contact. This lead to loosening but failures did not always result. The marvellous initial results following it's insertion were not maintained which lead to prosthesis being abandoned. In 1948, Mcbride overcame some problems of Judet prosthesis by introducing threaded stem which was screwed into femoral neck and locked by means of cross screws [27, 28]. He thought that femoral head should not be spherical as this caused pressure to br transmitted to the region of acetabular fossa.

In 1950, Moore [23, 29] introduced a self locking cobalt chrome alloy prosthesis, later models have slot in stem to allow the cancellous bone to penetrate and anchor the device. In 1953, Haboush of New York suggested the use of fast setting methyl methacrylate dental cement as a means of fixing the prosthesis firmly to the femoral shaft. In 1954, Thompson [30] advocated primary replacement arthroplasty of the hip for fracture neck of femur because of simplicity of the operation and rapid recovery of the function without necessity for elaborate rehabilitation measures. Innumerable reports similar to upper femoral prosthesis have appeared since then including those of McKeever [31] 1961 – used stainless steel. Movin (1957) used a long stem, Kevethe (1957) who used titanium stem, Fitzgerald (1952) used all purpose stainless steel head and neck prosthesis. Christiansen described trunnion type of bipolar prosthesis which allowed axial movement between head and neck of the prosthesis (flexion and extension) and other movements between prosthesis and acetabulum [32].

The erosion of bone on the pelvic side (acetabulum) brought attention to resurface the acetabulum. Metal – on – metal total hip arthroplasty described by McKee – Farrar [33] (1966) did not prove satisfactory because of friction and metal wear. The credit of modern Total hip replacement should go to Sir John Charnley [33, 34] (1967). His pioneer work on low friction arthroplasty using high molecular weight polyethylene cup and metallic femoral components revolutionized the management of hip problems [28, 35, 36].

The bipolar prosthesis was first introduced by James E Bateman and Gilberty [37] in 1974 as intermediate type between Moore type and total hip arthroplasty [38]. The commonly known versions of bipolar prosthesis are Monkduo pleet, Monk (1976), Hastings bipolar prosthesis [39, 40], modular Bipolar prosthesis (Biotechnic France) and Talwalkar's Bipolar endoprosthesis [41] (Inor, India). Bipolar prosthesis was designed to allow movement to occur not only between acetabulum and the prosthesis but also inner bearing which allows the axial movement between the head and neck of the prosthesis (ball and socket type). Hence universal movement takes place at the inter-prosthetic joint. Bipolar prosthesis was invented mainly to prevent the complications of acetabular erosions and prosthetic loosening as in the unipolar hemiarthroplasty [42]. Bipolar arthroplasty is an effective treatment for femoral neck fractures and that the rate of complications is acceptable, compared with that of unipolar hemiarthroplasty. Motion was found to be maintained at both bearing surfaces after 2 years although there was greater motion at the outer –cartilage interface [43].

B) **<u>Anatomy of Hip joint</u>** :

The hip joint is a multi axial ball and socket joint (spheroidal joint). The femoral head articulates with cup shaped acetabulum [44] . The articular surfaces are reciprocally curved and are neither co-existent nor completely congruent. The surfaces are considered spheroid or ovoid rather than sphecrical. The femoral cartilage is covered by articular cartilage except for a rough pit for the ligament of the head (ligament of teres). In front, the cartilage extends laterally over a small area on the adjoining neck. The cartilage is thickest centrally. Maximum thickness is in the acetabulum’s anterosuperior quadrant and the antero-lateral part of femoral head. The acetabular articular surface is an incomplete ring, the lunate surface, broadest above where the pressure of the body weight fall in erect posture. It is deficient below, opposite to the acetabular notch . The acetabular fossa within it is devoid cartilage, but contains fibroelastic fat largely covered by synovial membrane.

i) **Acetabular labrum**: It’s a fibrocartilagenous rim attached to the acetabular margin, deepening the cup. It’s triangular in cross section and it’s base is attached to the acetabular rim with the apex as the free margin. It bridges the acetabular notch as the transverse acetabular ligament, under which vessels and nerves enter the joint.

ii) **Fibrous capsule** : It’s a strong and dense attached above to the acetabular margin 5 to 6 mm beyond the labrum ,in front near the acetabular notch to the transverse acetabular ligament and the adjacent rim of obturator fossa. Behind, it’s attached about 1 cm above the inter-trochanteric crest. Below it’s attached to the femoral neck near the lesser trochanter. Anteriorly, many fibres ascend along the femoral neck as longitudinal retinacula containing blood vessels for both the femoral head and neck. The capsule is thicker antero-superiorly, where maximal stress occurs, especially in standing. Postero-inferiorly it's thin and loosely attached. The capsule has 2 layers – inner circular, forming the zona orbicularis around the femoral neck and blending with pubofemoral and ischiofemoral ligaments, and outer longitudinal layer. The circular layer is not directly attached to bone.

iii) **Synovial membrane** : Starting from the femoral articular surface, it covers the intra-capsular part of femoral neck, then passes to the capsule's inner surface to cover the labrum, ligament of the head and the fat in the acetabular fossa. It's thin on the deep surface of the iliofemoral ligament, where it is compressed against the femoral head. It communicates with the subtendinous iliac (psoas) bursa by a cicular aperture between the pubofemoral and the vertical band of the ilifemoral ligament.

iv) **Iliofemoral Ligament** : It's also known as bigelow' ligament. Triangular or inverted 'Y' shaped. It's one of the strongest ligaments in the body. It's apex is attached between the anterior inferior iliac spine and the acetabular rim and it's base to inter-trochnateric line anteriorly.

v) **Pubofemoral ligament** : It's triangular with the base attached to the ilio-pubic eminence, superior pubic ramus, obturator crest and membrane. Distally it blends with the capsule and deep surface of the medial part of iliofemoral ligament.

vi) **Ischiofemoral ligament** : it consists of superior ischiofemoral ligaments and the lateral and medial inferior ischiofemoral ligaments, extending from the ischium to the base of the femoral neck on the posterior aspect of the joint.

vii) **Ligamentum teres** : It's a triangular flat band with apex attached to the pit on the femoral head and base on either side of the acetabular notch. It varies in length and sometimes being represented only by synovial sheath.

Relations of hip Joint:

Anteriorly: (from medial to lateral) Pectineus, tendon of Psoas major, Femoral N and Vessels, Straight head of Rectus femoris, iliotibial tract.

Posteriorly: Obturator externus, Ascending branch of circumflex artery, Quadratus femoris, Piriformis, Tendon of obturator internus and gamelli separate the Sciatic N from the joint and N to quadrates femoris lies deep to Obturator internus.

Superiorly: Reflected head of rectus femoris, Gluteus minimus

Inferiorly: lateral fibres of pectineus and obturator externus tendon.

Vascular supply of hip joint:

- Obturator artery
- Medial circumflex femoral artery and
- Superior and inferior gluteal arteries.

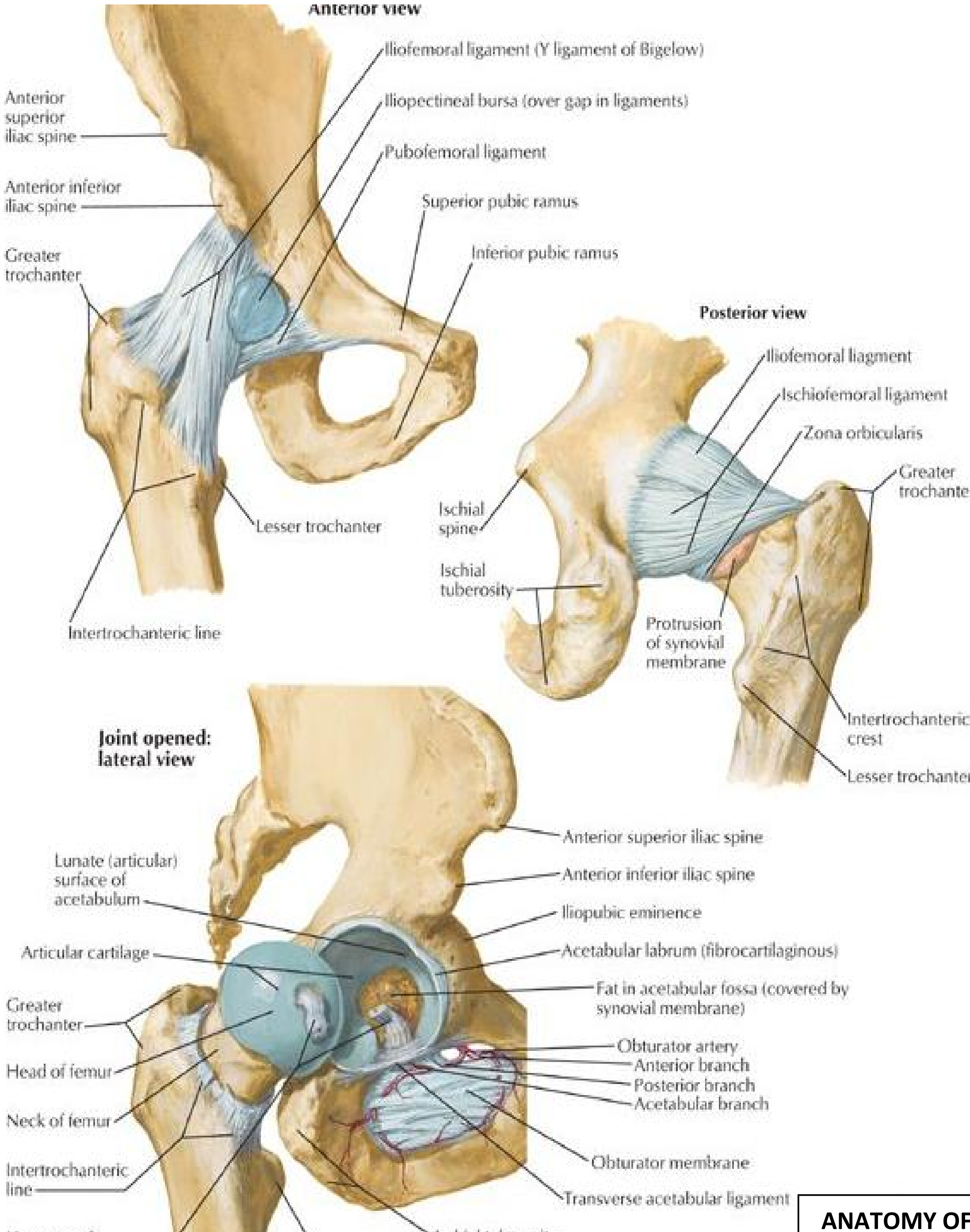
Nerve Supply of hip joint :

Hilton's rule : the nerve that supplies a muscle acting across a joint supplies the joint itself and the skin over the joint. Thus hip joint is supplied by

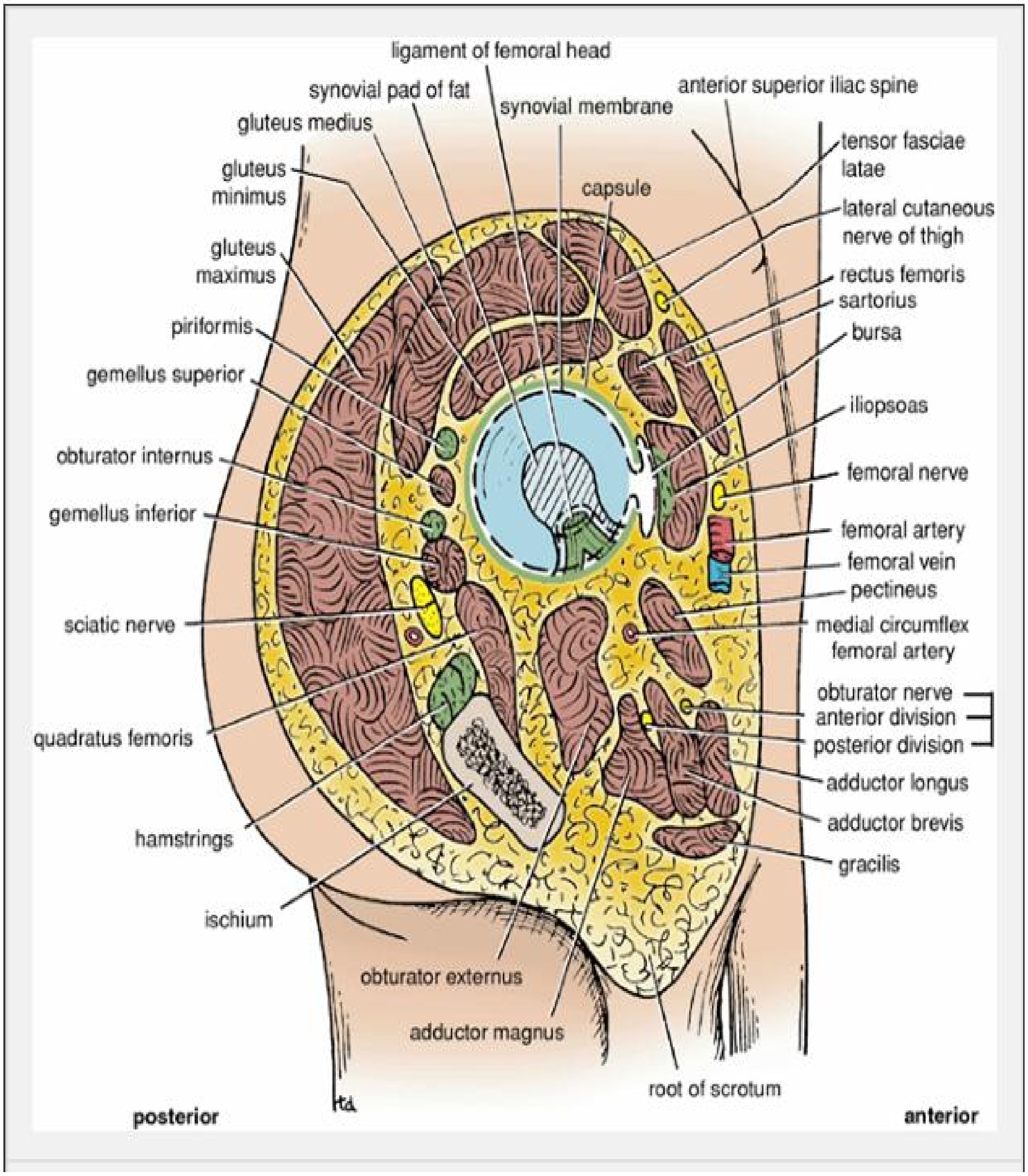
- Femoral N or it's muscular branches
- Obturator N
- Accessory obturator N
- N to quadratus femoris
- Superior gluteal N

Movements:

- Flexion – 90 to 100 degrees with knee extended and 120 degrees with knee flexed
- Extension – 10 to 20 degrees
- Abduction – 30 to 40 degrees
- Adduction – 30 to 40 degrees
- Medial rotation – 30 degrees
- Lateral rotation – 30 to 40 degrees



ANATOMY OF HIP JOINT



RELATIONS OF HIP JOINT

C) **Skeletal Anatomy**

The Proximal head of femur consists of a head, neck, greater and lesser trochanter.

i) **Head**: It's slightly more than a half a sphere, it faces antero – supero medially to articulate with the acetabulum. It's smoothness is interrupted postero-inferior to it's centre by a small, rough fovea.

ii) **Femoral Neck** : About 5 cm long, it connects the head to the shaft at an angle of about 127 degrees (113 to 136 degrees) [45]. This facilitates movements at the hip joint, enabling the limb to swing clear of the pelvis. The neck is also set up at an angle of 10 to 15 degrees anteversion. This twisting and turning presumably represents the developmental response of the femur to the upright position. The anterior surface of the neck is flat and is marked at the junction of the shaft by a rough inter-trochanteric line. The posterior surface is transversely convex and concave in it's long axis; it's junction with the shaft is marked by the rounded inter-trochanteric crest [9].

iii) **Greater Trochanter** : Large and quadrangular, it projects up from the junction of neck and shaft. It's postero-superior region projects superomedially to overhang the adjacent posterior surface of the neck, and here it's medial surface presents the rough trochanteric fossa. The trochanter's proximal border is level with the centre of femoral head.

iv) **Lesser Trochanter**: It's a conical postero medical projection of the shaft at the postero inferior aspect of it's junction with the neck.

Internal structure of Proximal end of femur :

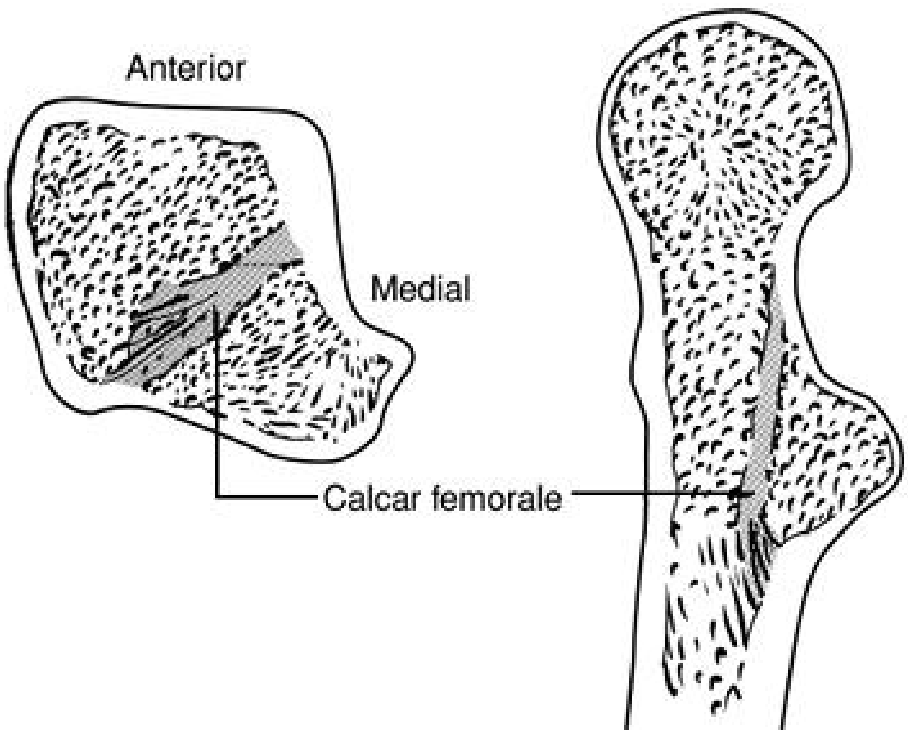
The apparently fragile but collectively strong lattices of struts and trusses seen in trabecular bone and skeletal forms such as tubes, H – girders and rigid predate human invention by millennia. Galileo recognized the significance of trabeculation and also asserted that hollow cylinders are weight for weight, stronger than solid rods.

Calcar femorale :

A thin vertical plate, the calcar femorale or as Bigelow (1900) described it as true neck of femur [46]. It ascends from the compact wall near the linea aspera into trabeculae of the neck. Medially it joins the posterior wall of neck. Laterally it continues into greater trochanter dispersing into general trabecular bone. It's thus in a plane anterior to the trochanteric crest and base of lesser trochanter. The hip prosthesis, rests on the calcar and it's shoulder abuts the calcar femorale and transmits the stress of weight bearing to the shaft via calcar.

Wolff's Law :

Every change in the form of a bone or of it's function is followed by certain definite changes in the internal architecture, which changes in accordance with mechanical loss. In essence, the law states that bony trabeculae are oriented along the line of stress, if direction of stress changes, the orientation of trabeculae also changes.



CALCAR FEMORALE

D) **Vascular anatomy of Femoral head**

Crock described the blood supply to proximal end of femur, dividing it into 3 major groups [47]:

i) An extra – capsular arterial ring at the base of femoral neck

ii) Ascending cervical branches of the arterial ring on the surface of the femoral neck

iii) Arteries of ligamnetum teres

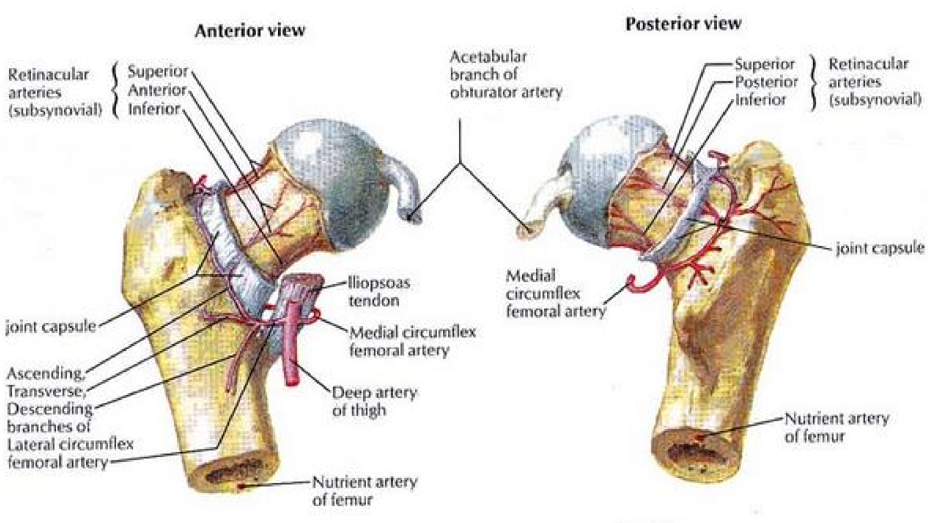
The extra-capsular ring is formed posteriorly by by large branch of medial circumflex artery and anteriorly by a branch from the lateral femoral circumflex artery [48]. The ascending cervical branches ascend on the surface of the femoral neck in anterior, posterior, medial and lateral gropus. Their proximity to the neck surface makes them vulnerable to injury in femoral neck fractures. The posterior group are the most important. Injury to these vessels during surgeries on the hip via posterior approach increases the risk of avascular necrosis of head of femur. As the articular margin of the femoral head is apporched by the ascending cervical vessels, a second less dictinct ring of vessels is formed, reffered to by Chung as the subsynovial intra-articular arterial ring. It's from this ring that vessels penetrate the head and are called the epiphyseal arteries. These are joined by the superior metaphyseal vessels and vessels from Ligamentum teres, which are branches of the obturator and medial circumflex arteries.

Clinical Significance :

In fracture neck of femur, the intra-osseous cervical vessels are disrupted. Femoral head nutrition then is dependent on remaining retinacular vessels and those functioning vessels in the ligamentum teres. The amount of femoral head supplied by the medial epiphyseal vessels varies from a very small area just beneath the fovea to the entire head.

If the fracture occurs distal to superior retinacular vessels and the displacement is not too great, both sources of blood supply amy remain intact and prognosis is good (less chance of avascular necrosis). Abnormal degree of rotator movement of the femoral head may destroy it's own blood supply as any other form of displacement.

With complete displacement of the head, only medial epiphyseal vessels supply the head. In approximately 30 % of cases the loss of blood supply is total, the foveolar vessels are insufficient and entire head becomes necrotic [49]. In 70 % of the cases, the nutrition of the femoral head is partially or wholly preserved by foveolar vessels. When avascular necrosis is partial, it usually involves a large area of the femoral head at the upper outer portion, the region about the fovea remaining viable [50].



VASCULAR SUPPLY OF FMORAL HEAD

E) **Biomechanics of Hip Joint**:

The hip is a ball and socket joint and thus has inherent structural bony stability relying less on the ligaments and muscles than in other joints. A ball and socket provides multi-axial freedom of movement which in some measure provides protection from sudden stresses. However, that force will be transmitted directly to the skeleton thus producing a variety of injury patterns. The advantage of the bony constraint is stability gained for walking and transferring from a standing to a sitting posture. A fracture disrupts the supporting structure and therefore eliminates the fucntinal performance of the hip joint. So the aim of the treatment is to provide support and anatomical realignment of bone fragments during healing to restore the function.

Bone has a vital role in providing the essential supporting framework and locations for muscle attachments. It consists of cortical and cancellous parts with their respective distinct mechanical properties. The cortical bone is more solid and rigid structure and it's anisotropic, a feature which makes the analysis of physical properties difficult. In 1867 Von Meyer and Culmann, an anatomist and an engineer, compared the trabecular arrangement of the cancellous bone within neck of femur to fairbarin crane and from this developed the stress trajectory theory of bone formation. There differing propotions of cortical and cancellous bone in the trochanteric region compared with neck region. It's generally regarded that 95 % of bone tissue in the neck is cortical variety, whereas the ratio is reversed in trochanteric region.

The work of paul on the calculations of direction and magnitude of the forces passing through the femoral during walking using standard gait analysis techniques and more direct measurement of an instumented Austin moore prosthesis by Rydell, produced similar figures, determined for the first time, that the trabecular pattern within head and neck of femur did correspond to the calculated loadings. The medial trabecular system has always been regarded as compression system in response to the maximum resultant compressive load. The Lateral trabecualr system was originally thought to have been laid down in accordance with Wolff's law (1870) as a result of tensile stresses. However the more recent work shows that the cortical shell of femoral neck is in fact entirely in compression, the maximum compression being on the medial aspect with tapering low compressive stresses on the lateral aspect of the femoral neck (Frankel 1960). Under normal physiological conditions, there is no tension in the femoral neck and the orginal neutral axis of the neck of femur is proposed by Koch (1917) does not exist. Only loading of the head and neck is in unphysiological position. Eg varus, is an element of tension occurring in lateral and superior aspect of femoral neck. Thus compression is major loading configuration of the bone of upper end femur with tension only in abnormal situations. Because of the multi-axial freedom in a low friction system within joint, torsion of the femoral neck is negligible.

Hip Joint Forces : There are 2 forces acting on the hip joint, ie, the body weight on the hip itself and the muscles acting across the joint. The movements produced by the muscle action during normal activities such as walking are quite considerable and provide a large magnification factor to the body weight applied directly on the joint. It's seen that in level of walking peak loads as much as 5 to 6 times the body weight are occurring in the hip. This high level of loading accounts for many problems associated with fractures. When the weight of the body above the lower extremities rests equally on two normal hip joints, the static forces on each hip is one half of, or less than one third, the total body weight. For example, the right lower extremity is lifted as in the swing phase of walking, the weight of the right lower extremity is added to the body weight, and the centre of body gravity, normally in median sagittal plane, is displaced to the right. The abductor muscles exert a counter – balancing force to maintain equilibrium. The pressure exerted on the head of femur is the sum of these 2 forces. Each force is related to relative length of levers. If abductor lever is one third that of the lever arm from the head to the centre of gravity, so the downward pull of the abductors must be 3 times the force of gravity to maintain balance. Therefore the total pressure on the head is 4 times the superimposed weight. The longer abductor lever (i.e., the more laterally placed insertion of the abductors), the less the ratio between the levers, the less the abduction force required to maintain the balance and less pressure force exerted on the femoral head [51, 52].

The estimated load on the femoral head in the stance phase of the gait and during straight leg raising is about 3 times the body weight. Crowninshield et al [51, 52] calculated the peak contact forces across the hip during gait as ranging from 3.5 to 5 times the body weight. When lifting, running or jumping the load may be upto 10 times the body weight.

F) <u>Bipolar Prosthesis</u>

Description of Implant:

The bipolar prosthesis introduced by James. E. Bateman and Gilberty during 1974. Similar Bipolar prosthesis were later manufactured with some modifications, mainly in the design of stem. Other commonly known versions are Monk duo pleet (Monk 1976), Hasting's bipolar prosthesis (Biotechnic, France) and Bipolar endoprosthesis (Inor India, Talwalker type).

The provision of completely mobile head element and the addition of another head surface motion in the acetabulum create a compound system. This provides a greater distribution on the bearing surfaces, thus minimizing wear and tear changes both on the implant and on containing tissues. Such considerations were met by building a prosthesis of cobalt – chromium alloy (Vitallium Howmedica), consisting of a femoral stem with a collar, neck and 22 mm spherical bearing at it's proximal end. Locked onto this bearing is a capped metallic cup or cap, i.e., the head which constitutes a second bearing surface which articulates with the acetabulum. The assembled device represents an integrating bearing system for the hip joint replacement. The Bipolar prosthesis (Talwalker type) has got a stem length of 157 mm, thickeness is 8 mm and material for the stem is Stainless steel AIS 316. The stem has got fenestration which is optional. It has got vertical shoulder which sits on the medial calcar, has long neck, of length 35.0 mm, neck shaft angle is 125 degrees, diameter is 19.00 mm. The size of the femoral head is 26 mm. The femoral head articulates with the inner surface of acetabular cup which is covered by (HDPE) High Density PolyEthylene and outer surface is stainless steel. The size of acetabular cup will vary from 39 to 51.

Simplest of currently available Bipolar prosthesis like Indian version and monk prosthesis have an Austin Moore type stem and the small femoral head cannot be detached from the outer metallic cup – (UHMWPE) Ultra High Molecular Weight PolyEthylene insert complex. Better and modified versions of Bipolar prosthesis have a modular systems with inter-changeable stems (fenestrated, solid, straight, long, pororus, press fit, cement compatible, Interchangable). Small diameter head (metallic or ceramic) which allows adjustment of neck length, different sizes of outer metallic cup UHMWPE, insert with press fit locking mechanism over small head (Biotechnic, France). The movements between 2 interfaces contribute to greater range of motion and possibly less migration of the prosthesis. Modular version of Bipolar prosthesis can be easily converted to total hip replacement in case of any complications occurring in acetabular side.

Principle of Bipolar prosthesis: Acetabular wear is diminished through reduction of total amount of motion that occurs between the acetabulum and metallic outer shell by interposition of second low – friction inter-bearing within the implant. Because of compound bearing surface, bipolar designs provide greater overall range of motion than either unipolar designs or conventional total hip arthroplasty.

Biomechanics of the implant: the forces on the joint act on coronal palne, but as the body's centre of gravity (in the midline anterior to S2 vertebral body) is posterior to the axis of the joint, they also act in saggital plane to blend the stem of the prosthesis posteriorly [53]. During gait cycle, Forces are directed against the prosthetic femoral head from a polar angle between 15 and 25 degrees anterior to sagittal plane of the prosthesis during stair climbing and Straight leg raising, the resultant force is applied at a point further anterior on the head. Such forces is applied at a point even further anterior on the head. Such forces cause posterior deflection or retroversion of femoral component.

The low coefficient of friction of a metallic head articulating with a polyethylene cup as a bearing is fundamental to bipolar arthroplasty. The coefficient of friction is the measure of resistance enecountered in moving one object over the another [52]. It varies according to material used the finish of the surfaces of the materials, the temperature and whether the device is tested in the dry state or with a specific fluid as a lubricant. Load may be another factor. Frictional torque forces are produced when the loaded hip moves through an arc of motion. It's the product of frictional force times length of the lever arm, that is the distance given point only surface of the head moves during given arc of motion [52].

Ideal Prosthesis : The ideal femoral reconstruction reproduces the normal centre of rotation of femoral head . this location is determined by 3 factors:

i) **Vertical Height (Vertical offset) –** Restoring this distance is essential to correct the leg length. Using a stem of variable neck lengths provides a simple means of adjusting this distance.

ii) **Medial Offset (Horizontal offset) –** Inadequate restoration of this offset shortens the moment arm of the abductor musculature and results in increased joint reaction force, limp and bony impingement which may result in dislocation.

iii) **Version of femoral neck (Anterior offset) –** Version refers to the orientation of the neck in reference to cornal plane and it's denoted as anteversion or retroversion. Retroversion of the femoral version is important in achieving stability of the prosthetic joint. The normal femur has 10 to 15 degrees of anteversion.

Recent Modifications:

Axes of metallic and polyethylene cups are now eccentric so that with loading of hip, metallic cup rotates laterally rather than medially 7 thus avoids fixations in varus position and avoids impingement of head on edge of the cup which causes friction of polyethyelene bearings insert and dislocation.

Dr. Della pris introduced an Alumina ceramic Bipolar prosthesis the advantage of which is ver low wear rate (2 microns / year compared to 200 microns of polyethylene per year) [54]. However, polyethylene has an effect of protecting the subchondral bone from fractures. Therefore, the ceramic bipolar should have a PE jacket between ceramic bearing surface and the outer head. A finite element analysis showed that ssuch a jacket is effective at reducing the prosthesis stiffness.

Advantages of Bipolar prosthesis:

1) ***Wide range of movements***: It's due to size and geometry of inner bearing, i.e., the rim of polyethylene insert on metallic neck of prosthesis, after a certain arc of abduction – adduction movements and then the further movement occurs between acetabulum and outer metallic cup of prosthesis.
2) ***Stability – improved*** : At the degree of movement of the inner bearing, when the joint tends to dislocate, it's prevented by movement of the outer bearing in opposite direction.

3) ***Prevents the Complications – like*** : Acetabular erosion and Protrusio acetabulli, loosening of the stem. The bipolar prosthesis is designed as an alternative to unipolar endoprosthesis. It works on the principles of ‘low friction arthroplasty’. The bipolar has 2 layers of movements with an inner low friction bearing, where small metallic head articulates UHMWPE insert and outer stainless covering – polyethylene insert which articulates against the acetabulum. A friction differential thus exists at 2 planes of movements, so that even in presence of minute irregularities of acetabular surface, most of motion tends to occur at the inner bearing. The friction between acetabular cartilage and the outer metallic cup is markedly reduced. This reduced reaction against acetabular cartilage is better tolerance of bipolar prosthesis, reduces erosion and corresponding reduction in penetration of the acetabulum. Shock –absorbing character of the UHMWPE insert also reduces impact load on acetabulum during weight bearing. The small diameter of femoral of inner head reduces the resistance to motion and thereby also reduces the forces of mechanical loosening of femoral stem. Bipolar prosthesis designed primarily with aim of reducing the frictional stress and thereby decreasing the acetabular erosion and loosening of the stem. The complications of fracture such as Non-union and Avascular necrosis which could occur following Internal fixation are avoided.

4) ***Increased life span of the prosthesis*** : As it’s a low friction arthroplasty, the wear and tear is minimal in both implant and the acetabulum. Hence the life span of the prosthesis is more when compared to other universal endoprosthesis.

5) ***Can do THR later*** : Bipolar design affords the advantage of low friction arthroplasty without implanting a separate acetabular component. As absence of fixed acetabualr

cup eliminates the potential complications with use of Methyl methacrylate for fixation of the acetabular cup, which increases the duration of surgery and complications associated with fixing the cup with cement.

6) Immediate weight bearing and avoids bed-ridden complications

Note :

Bipolar prosthesis was originally devised for use in cases of fracture neck of femur to overcome the long term complications of Moore’s and Thompson’s prostheses like Acetabular erosion, protrusion acetbaulli and proximal migration of the prosthesis. Till date the bipolar prosthesis has been extensively used in traumatic cases and several long term study has been published, which clearly document the improved results as compared to single assembly prosthesis.

F) **<u>Fracture Neck of Femur</u>**

Femoral neck fractures are uncommon in young patients with normal bone and in older patients of races in which osteoporosis is uncommon such as black Americans, South African Bantu. Femoral neck fractures are much more common in elderly women. By the age of 65, 50 % of women have a bone mineral content below the fracture threshold and by age of 85 100 % women have a bone mineral content below this threshold.

Mechanism of Injury :

Patients suffering from a fracture neck of femur had trivial or minor injuries, only a few involve major trauma. Kocher suggested 2 mechanisms of injury. First is fall producing a direct blow over greater trochanter and second is Lateral rotation of involved extremity. Thirdly recently suggested mechanism is cyclical loading which produces micro and macro fractures. In case of young patients the trauma is major, usually resulting in a direct force along the shaft of the femur with or without rotational component.

Mechanism of Bone failure :

A structure will fail if it suffers from the over loadings, and such a situation would arise if the system is unable to absorb the energy applied to it. In the hip joint this over loading can occur as a result of number of independent but often inter – related factors. The following being important : falling, Impairment of energy absorbing mechanisms and bone weakness.

i) Falling : In standing, the body possesses a considerable amount of potential energy. In falling, the potential energy converts to kinetic energy, which upon impact with the floor must be absorbed by the structures of the body, if a fracture is not to occur. In a average sized human amount of potential energy absorbed in a fall would be approximately 4000 kg/cm and the energy absorbing capacity of the upper end femur is only about 50 kg/cm. Thus if a bony injury is not occur energy absorbing mechanism must operate.

ii) Impairment of energy absorbing mechanisms: The principle dissipation of energy is done by active muscle contraction. This dissipation requires time and in the event of high speed trauma, there’s not sufficient period for muscle contraction to absorb energy before over loading of the bone has occurred and bone fails. In elderly the neuromuscular co-ordination may be slower and thus the energy absorption may not be rapid enough to prevent a fracture. It’s interesting the fractures of neck of femur are more common in patients with Rheumatoid arthritis, Diabetes mellitus who are likely to have neuromuscular defect (Alffram 1964). In the elderly the normal protective muscle contraction in the event of a slip rather than a fall may lead to an uninhibited muscle contraction around the hip and produce sufficient force to fracture neck of femur without implicating any other fracture.

iii) Bone weakness : In the presence of osteoporosis or osteomalacia there is reduction in the bone strength to approximately to $3/4^{th}$ of the normal healthy young bone (Frankel 1974) and a lower energy absorbing capacity leads to failure. Griffiths et al (1971) showed that fatigue fractures can occur in elderly if the neck of femur is cyclically loaded with in the physiological range, senile subcapital fractures in the osteoporotic bone due to fatigue, preceded by an accumulation of isolated trabecular fatigue fractures have been demonstrated by Freeman et al (1974). Thus fatigue of an elderly bone can occur without a fall.

iv) Patterns of femoral neck fractures: It's influenced by the resultant of force which is applied at the moment prior to fracture. If the normal resultant line of force under physiological conditions is considered, it can be seen that this force can be resolved into one perpendicular to the axis of femoral neck and the one in the line of axis of the femoral neck. If the resultant line of force acting at the moment, before fracture is altered from the physiological position, then relative size of these 2 components will be altered. Frankel in 1950 has shown experimentally that if bending component is increased relative to compressive component (a ratio of 1.6) then a transverse fracture is likely. If the bending component is reduced to compressive component (a ratio of 1.7) a subcapital fracture with a spike, finally a subcapital fracture is produced. The resultant line of forces from the muscle contractions produce a subcapital fracture experimentally; a pattern of fracture seen after an eltrocution. Basal and inter-trochanteric fractures have not been explained satisfactorily since they could not be reproduced satisfactorily.

Classification of Femoral neck Fractures:

Any system of classification of fractures is useful only if it considers the severity of bone leision and serves as a basis for determining the type of treatment used, the chance of achieving a stable rigid surgical fixation and the likely outcome of treatment. In intra-capsular fracture neck of femur, classification should sid in prediction of the risks of Non-union and Avascular necrosis.

1) Anatomical classification
2) Pauwel's classification
3) Garden's classification
4) AO Classification

Anatomical Classification: The first anatomical classification of fracture neck of femur was done by Sir Astley Cooper in 1823 [55]. He classified them into

A) Intra-capsular

B) Extra-capsular

Intra – capsular fractures further classified as

i) Subcapital fractures : Fracture line immediately beneath the head along the old epiphyseal plate.

ii) Transcervical Fractures : Fracture line passing across the femoral neck between femoral head and the greater trochanter.

iii) Basicervical fractures

Banks had divided femoral neck fractures, anatomically into 4 types. Classical subcapital, wedge subcapital, Inferior beak fracture and Mid neck fracture. First 3 are essentially subcapital fractures.

Before the advent of effective internal fixation, Impaction was the most important prognostic factor, whether occurring at the time of injury or being produced subsequently by attending clinican. Consequently early systems of classification stressed the presence of impaction or displacement of the intra-capsular fracture. This is best exemplified by Waldenstorm in (1924) [56] who classified them into: Impacted Abduction fracture (Valgus), Impacted Adduction fracture (Varus) and Non – impacted fractures.

Pauwel's Classification:

Based on the fracture line and the angle of inclination with the horizontal plane Pauwels (1937) classified subcapital fractures into 3 types [56].

Type I – Fracture line is less than 30 degrees from the horizontal

Type II – Fracture line is between 30 to 70 degrees from the horizontal

Type III – Fracture line is > 70 degrees to horizontal.

As a fracture progresses from the type I to type III, the obliquity of the fracture line increases and theoretically the shear forces at the fracture site also increase. The incidence of union is also good in Pauwel's type I due to imapaction and the incidence of AVN is about 13 %. Where as in Pauwel's type II and III the incidence of Nonunion is 12 and 8 % and the incidence of AVN is 33 % and 30 % respectively.

Garden's Classification :

He believed that various types of femoral neck fractures represent different stages of the same displacing movement. In his classification, the direction of medial or compression trabeculae rising superiorly into the weight bearing dome of the femoral head is used to indicate the degree of rotation in the fracture in AP radiograph [56, 57].

Type I – Fracture is incomplete, with the head tilted in postero-lateral direction. This is an impacted fracture.

Type II – Fracture is Complete, but no displacement

Type III – Fracture is complete with partial displacement.The trabecular pattern of the femoral head does not line up with that of the acetabulum, demonstrating incomplete displacement between the femoral fracture fragments.

Type IV – Complete fracture with complete displacement. The trabeculae of femoral head realign themselves with trabaeculae within the acetabulum.

A.O. Classification :

Fracture neck of femur is based on the modification of Pauwel's grading with further sub-division into subcapital, transcervical, basicervical and mid – cervical [52]. In this system fractures of femoral neck are classified as:

Type B1 : Sub – capital with no or minimal displacement

Type B2 : Transcervical

Type B3 : Displaced sub – capital fracture

Type B1 : Subdivided into B1.1 - Impacted in valgus of 15 degrees or more

B1.2 – Impacted in Valgus of less than 15 degrees

B1.3 – Non-impacted

Type B2 : Subdivided into B2.1 – Basicervical

B2.2 – Midcervical with adduction

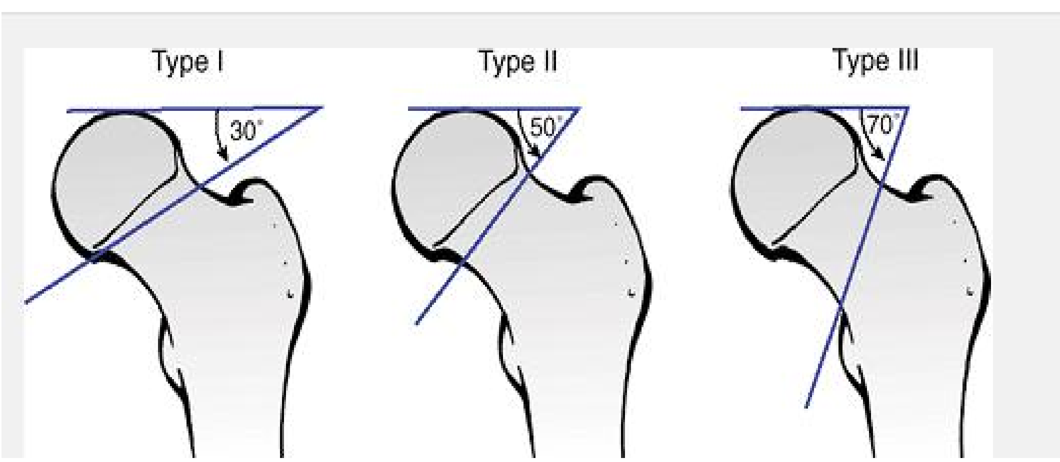
B2.3 – Midcervical with shear

Type B3 : Subdivided into B3.1 – Moderately displaced in varus and external rotation

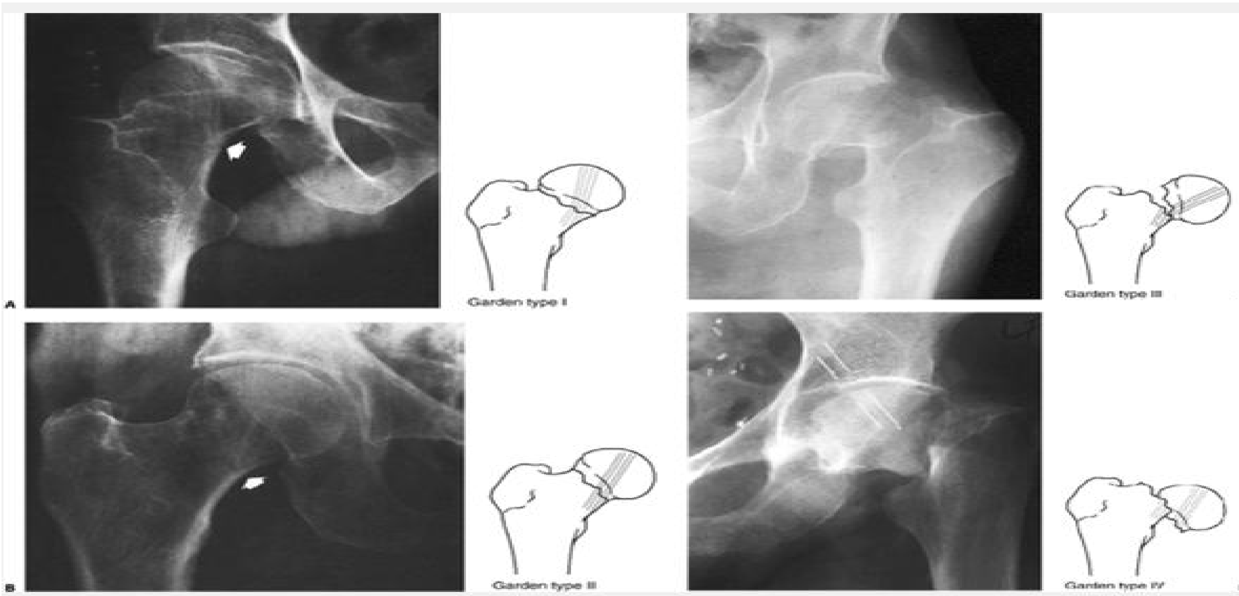
B3.2 – Moderately displaced with vertical translation and external rotation

B3.3 – Markedly displaced

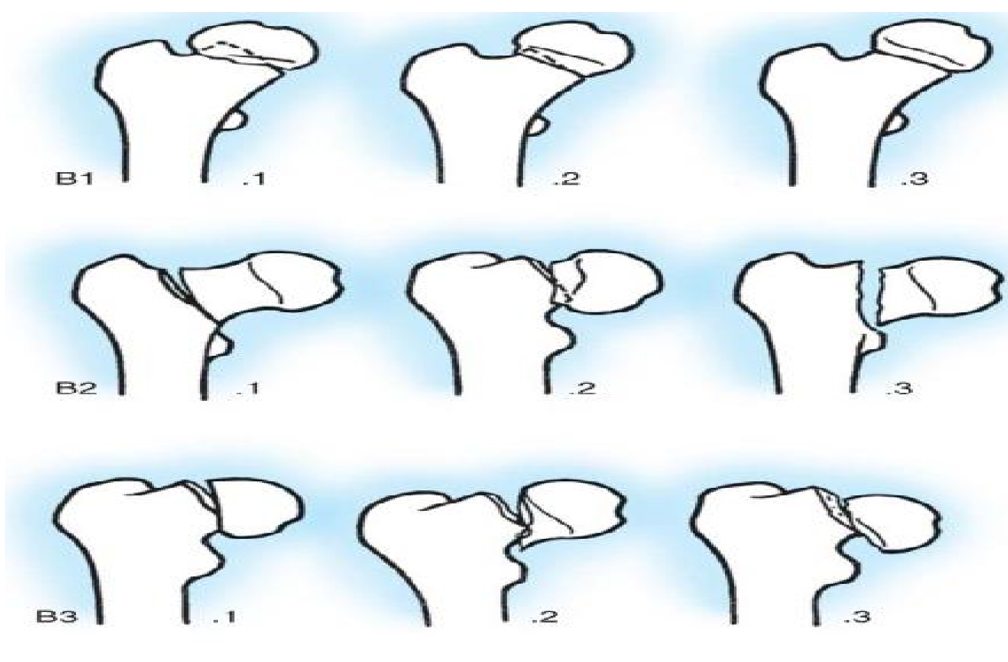
Type B3 has the worst prognosis.



Pauwell's Classification



GARDEN'S CLASSIFICATION



AO CLASSIFICATION OF FEMORAL NECK FRACTURES

Radiography of the Hip region:

The hip joint is usually diagnosed in a antero-posterior (AP) view with heel slightly seaparated and the toe toe symmetrically forwards and medially. In this position the femur is rotated medially, the femoral neck is parallel to the film. In the normal the line of the upper margin of the obturator foramen follows the same curve that of under surface of the neck and the medial side of the shaft of femur (Shenton’s line). The continuity of this curve is unaffected by small difference in the potion of hip joint. In case of fracture or dislocations there’s a break in this line. The upper end of femur is composed of 2 distinct systems of trabeculae [58]. In the frontal section these trabeculae are seen to form 2 arches. One arising from the medial (inner) cortex of the shaft of femur and the other taking origin from the lateral (outer) cortex. The trabeculae forming these arches are called Compressive and tensile trabeculae respectively because they are disposed along the lines of maximum compression and tension stresses produced in the bone during weight bearing. These trabeculae have been divided into following 5 groups:

a) Primary Compressive group : the upper most compression trabeculae extend from the medial cortex of the shaft to upper portion of the head of femur run in a slightly curved radial lines. Some of these are thickest and most closely packed.
b) Secondary Compressive group : the rest of the compression trabeculae which arise from the medial cortex of the shaft constitute the secondary compressive group. These arise below the principle compressive group and curve upwards and laterally towards the greater trochanter and the upper portion of thee neck. The trabaeculae in this group are thin and widely spaced.

c) Primary Tensile group : The trabeculae which spring from the lateral cortex immediately below the greater trochanter group. The trabeculae are thickest among the tensile group curve upwards and inwards across the neck of femur to end in the inferior portion of the femoral head.

d) Secondary tensile group: The trabeculae which arise from the lateral cortex below the principal tensile trabeculae. The trabeculae of this group arc upwards and medially across the upper end of femur and more or less irregularly after crossing the midline.

e) Greater trochanter group: Some slender and poorly defined tensile trabeculae arise from the lateral cortex just below the greater trochanter and sweep upwards to end near it's superior surface.

In the neck of femur, the principle compressive, the secondary compressive and primary tensile trabecuale enclose an area containing some thin and loosely arranged trabeculae. This area is called 'Ward's triangle'. The trabeculae of upper end of femur can be studied by making radiographs of hip region using an exposure sufficient to delineate the macroscopic details of internal architecture of bones. The thick trabeculae appear as dense continuous lines while the delicate ones are not visible. Thus the areas like Ward's triangle appear empty while rest of the trabeculae are delineated depending on their density.

Singh's Index: It's the grading of trabecular appearance in X-ray. There are 6 grades:

Grade 6: All trabeculae groups are visible. Upper end of femur is completely cancellous.

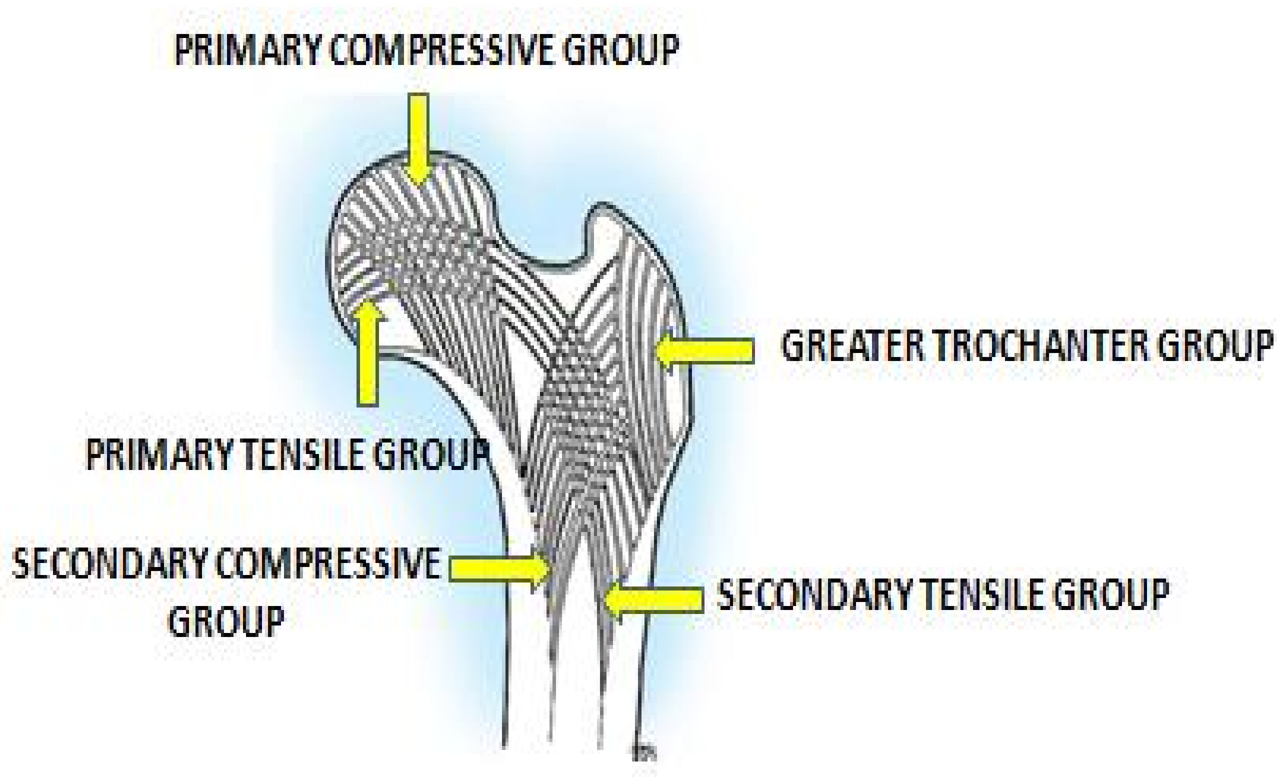
Grade 5: Principle (primary) tensile and compressive trabeculae are accentuated. Ward's triangle is prominent. Secondary trabeculae are absent.

Grade 4 : Principle tensile trabeculae are reduced. But still can be traced from the lateral cortex to the upper end of femur.

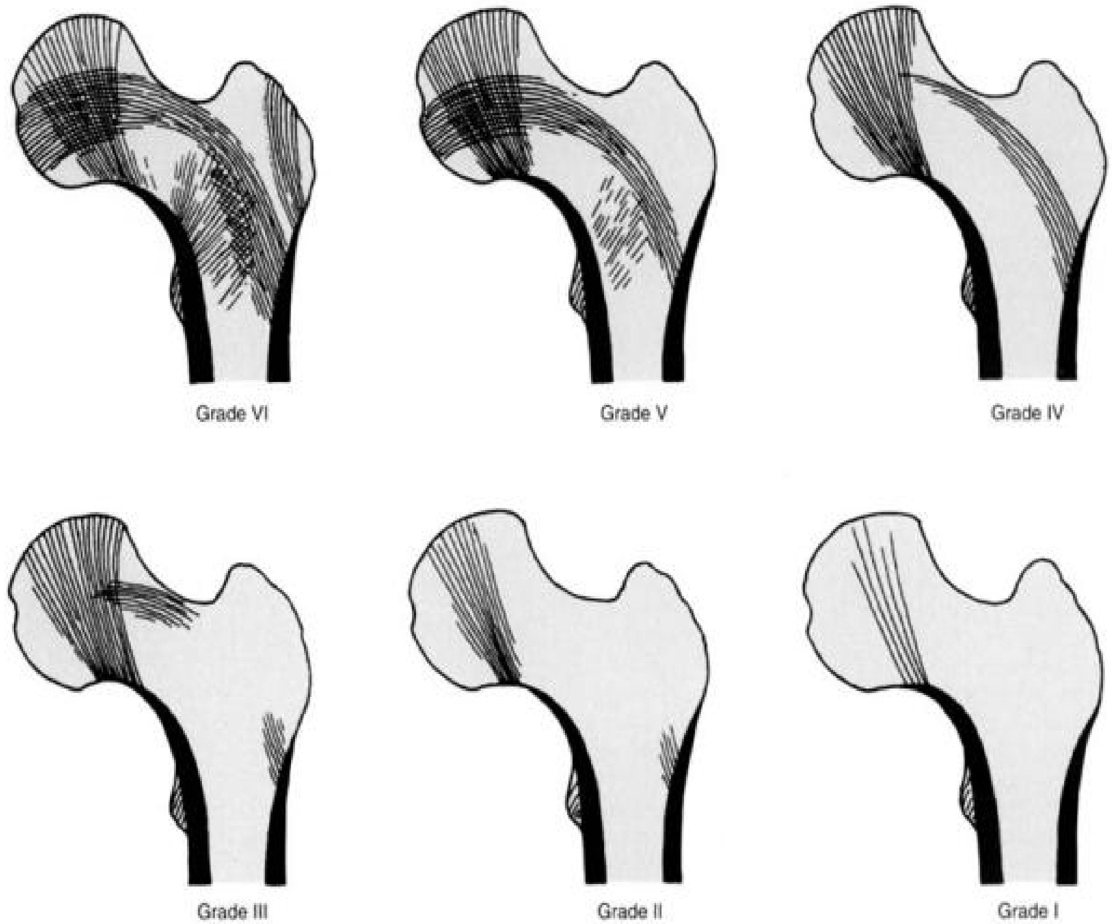
Grade 3 : Break in tensile trabeculae opposite the greater trochanter

Grade 2 : Only principle compressive trabeculae are found. Others are more or less completely resorbed

Grade 1 : Even principle compressive trabeculae are markedly reduced.



TRABECULAR PATTERN



SINGH'S INDEX

Complications of fracture :

i) Non-union:

Nonunion is reported to be true after undisplaced fracture, but occurs in 20 to 30 % displaced fractures. As the age advances the rate of non-union increases sharply. Factors that have been incriminated as causes of non-union are 1. Vascular and fracture anatomy, 2. Intra-capsular nature of fracture, 3. Absence of cambium layer of periosteum, 4. Poor surgical technique, 5. Comminution of the posterior cortex, 6. Age of the patient, 7. Difficulty in reduction of fracture and maintaining reduction.

In displaced fracture neck of femur retinacular vessels are damaged in addition to disruption of intra-medullary supply and proximal fragment will be devoid of blood supply. Since thee shearing stresses act in fractures with a vertical inclination fractures fails to unite. Phemister emphasized that lack of cambium layer of periosteum in femoral neck makes it vulnerable for Non-union. Union has to depend on endocallus and creeping substitution. Synovial fluid bathes the fracture site and haematoma does not form. Also synovial fluid contains angiogenesis inhibiting factor which prevents neovascularisation across the fracture site.

Inadequate reduction or poor internal fixation technique was the cause of nonunion in a series reported by fielding et al. Barnes et al, reported increased incidence of Nonunion in elderly with severe osteoporosis. More than 60 % of the patients with posterior cortical comminution developed nonunion in a series reported by Banks. Posterior cortical comminution associated with varus leads to 100 % nonunion.

ii) Avascular necrosis :

It's one of the 2 important complications of femoral neck fractures. Aseptic necrosis is actual death of the bone secondary to ischemia, an early phenomenon after femoral neck fracture and is a microscopic event. Late segmental collapse is the collapse of the subchondral bone and articular cartilage that overlies the infracted bone. This collapse results in articular incongruity, pain and degenerative joint diseases. The collapse occurs late in the sequence of the ischemic event and is recognized as a clinical entity. Not all the patients with aseptic necrosis go late segmental collapse.

Late segemental collapse can occur as late as 17 years after the fracture. In 80 % patients it's evident within 2 years radiographically. Incidence of late segmental collapse varies from 7 % to 27 %. It occurs in 10 to 20 % of undisplaced fractures and 15 to 35 % of displaced fractures. Barnes et al. have reported increased frequency in women than in men. The tender vascular buds during revascularisation of fracture can be repeatedly torn if there is persistent motion at the fracture site owing to poor stabilization. Moore demonstrated that in poor reduction the surface area for blood vessels to grow up the remaining neck is decreased so that the incidence of aspetic necrosis and late segmental collapse is increased when the fracture is poorly reduced.

Smith demonstrated that excessive rotation about the longitudinal axis or excessive vlagus at the time of reduction may obstruct the remaining blood supply in the ligamnetum teres. Fielding and Lowell mention that insertion of a screw for fixation may rotate the femoral head fragment, thereby obstructing the remaining blood supply in the capsule and ligamentum teres. A nail placed superiorly and laterally in the femoral head may disrupt the lateral epiphyseal vessels and therefore increase the risk of AVN. According to Boyd and George all the patients with late segmental collapse develop arthritic changes if the patient bear weight long enough.

Treatment:

1. **Treatment of Undisplaced fractures of femoral neck :**

   Closed reduction and internal fixation with multiple cannulated screws or with a compression screw and side plate and accessory screws in cases with comminuted lateral cortex [56 – ashok].

2. **Treatment of displaced Intracapsular fractures of femoral neck :**

Age in Years	Functional Status	Treatment
< 65	**Community Ambulator**	**CRIF**
		ORIF if necessary
65 – 75	**Community Ambulator**	**CRIF**
		Bipolar H.A if CRIF unsuccessful
>75	**Community Ambultor**	**Bipolar H.A**
>75	**Minimal House – hold Ambulator**	**Unipolar H.A**
NA	**Pre – existant Arthritis**	**Total Hip Replacement**
NA	**Non – Ambulator**	**CRIF**

CRIF - Closed Reduction and Internal Fixation, ORIF _ Open reduction and Internal Fixation, H.A – Hemi – arthroplasty.

Indications of Prosthetic replacement in femoral neck fractures [52]:

Relative :

i) Advanced Physiological age : patient's should be 65 years or older with life expectancy of not more than 10 to 15 years

ii) Fracture – dislocation of hip: when the superior weight bearing surfaces is fractured, prosthetic replacement is preffered.

iii) Acutely Oblique fracture or Pauwel's Type II and III : these are known for nonunion, if head is preserved.

iv) Severe osteoporosis : where internal fixation results in collapse of the head and loss of the position.

Absolute :

i) Fracture could not be satisfactorily reduced or securely nailed

ii) Failed internal fixation several weeks later

iii) Some pre-existing leision in the head – such as AVN where fracture has precipitated the need for replacement arthroplasty.

iv) Old undiagnosed femoral neck fractures : Untreated, unreduced unimpacted fracture >3 weeks old is better managed with a prosthesis.

v) Pathological fractures of femoral neck with short life expectancy

vi) Fracture neck of femur with complete dislocation of head

vii) Patients who are mentally ill and who will jot co-operate internal fixation weight bearing protocol

viii) Patient who probably can't withstand 2 operations

ix) Malignancy

x) Neurologic disorders such as patients with uncontrolled epileptic seizures and uncontrolled parkinsonism.

Contraindications :

i) Pre-existing Sepsis

ii) Active young patient with fracture neck of femur

iii) Garden's stage I and II

iv) Non – ambulatory senile patients.

Complications of arthroplasty :

Early :

i) Nerve injuries : The sciatic, femoral, obturator and peroneal nerves can be injured by direct surgical trauma, traction, pressure from the retractors, extremity positioning, limb lengthening and thermal or pressure injuries from cement. The incidence of nerve injury has been reported to 0.7 % to 3.5 % in primary arthroplasties [52].

ii) Haemorrhage and Haematoma formation : It's common in case of familial blleding tendency, recent salicylate use, anticoagulant therapy, liver disease, paget's disease, gaucher's disease and haemophilia. More common in posterior approach.

iii) Bladder injuries and urinary tract complications

iv) Limb length discrepancy: Most often the limb that is operated on is lengthened. Lengthening may result from insufficient resection of bone from the neck, use of prosthesis with a neck that is too long, or from changing the centre of rotation of acetabulum.

v) Vascular injuries are rare, However they can pose a threat to survival of the limb and the patient.

vi) Dislocation and subluxation : factors contributing are ; 1. Previous hip surgery, 2. Posterior approach, 3. Faculty postioning of implant, 4. Impingement of femur on pelvis, 5. Inadequate soft tissue tension, 6. Weak abductor muscles, 7. Extremes of positioning in post-operative period, 8. Soft tissue interpotion

vii) Fractures : Fractures of femur can occur during insertion of implant. Post – operative femoral fractures may be due to stress fractures caused by increased use of limb after surgery, stress raisers and trauma.

viii) Infection : Risk factors are diabetes, rheumatoid arthritis, sickle cell anemia, urinary tract infections and prolonged operative time. Infection rate was almost 3 times higher in posterior approach than in anterior approach.

ix) Thrombo-embolism is the most serious complication of hemiarthroplasty. Risk factors are previous episode of Deep vein thrombosis, venous surgery, varicose veins, prior orthopaedic procedures, advanced age, malignancy and heart failure.

Late complications :

i) Hetero – topic ossification : More commonly associated with excessive bone resection and soft tissue dissection [57].

ii) Implant loosening : It’s most serious long term complication

iii) Acetabular protrusion : This is assessed by measuring medialisation of acetabular line compare with normal or immediate Post-op radiograph.

iv) Acetabular erosion: it's determined by measuring the change in the thickenss of acetabular cartilage.

v) Painful prosthesis : Salvatti [59, 60] (1972) and Coastes feel that principle late complication of endoprosthetic replacement is pain. Gringas [61] (1980) Whittaker[62] (1974) report that the hip pain may be present with prosthetic loosening or with distal or proximal migration of the prosthesis.

G) LITERATURE REVIEW OF RADIOLOGICAL ASSESSMENT OF IPJ MOVEMENT

Certain aurthors believed that in normal acetabulum, the cartilage – prosthesis junction has low coeffiecient of friction (in contrast to arthritic joint) and therefore even Bipolar prosthesis may work as unipolar arthroplasty, with movements occurring between Acetabulum and outer cup of bipolar prosthesis.

1. Philips TW (1987) had done a study on Fluroscopic movement in 100 patients who had undergone Bateman Bipolar arthroplasty. Out of these 100 patients Group I had 76 patients with arthritis of hip and Group II had 24 patients with neck of femur fractures. In 80 % of group I patients, the prosthesis retained Bipolar function at the end of 4 years follow-up study as compared to only 25 % of group II patients retained the bipolar functioning of the prosthesis. They concluded that the inter-prosthetic joint motion is preserved well in arthritic patients rather than the fracture cases [63]
2. Verbene G.H.M (1983), did a radiological study of movements of 2 components in Variokopf prosthesis in 20 patients with fracture neck of femur during Immediate, 1 month and 3 months post-operative period. He observed that the IPJ lost mobility and at 3 months it became almost completely stiff with inter-prosthetic joint motion of only 16.9 % being retained [64]. So he concluded that eventhough there are advantages in treating of fracture neck of femur with hemiarthroplasty, the advantages of the prosthesis with inner bearing motion is very minimal.
3. Bochner RM , in a study 120 patients with femoral neck fractures undergone Bateman Bipolar prosthesis of whom 26 patients were assessed radiologically for

interprosthetic joint motion. They concluded that Bipolar fuction was retained and the motion was shared between both the joint interfaces [43].

4. In a study conducted Anil kumar rai, from Banaras hindu university, varanasi, india during the period march 2003 to january 2011 treated with BHU bicentric bipolar prosthesis, showed that in cases of fracture neck of femur, the percentage of total abduction occurring at the interprosthetic joint at 3 months follow-up was 33.74% (mean value of all the patients), which fell to 25.66% at 1.5 years and then becomes stationary at 6 years which was about 20 %. Higher Inter-prosthetic joint motion was observed in the arthritic group treated same type of bipolar prosthesis.

Oxford Hip Score (OHS):

- It's useful to Assess the outcome after surgical procedures by measuring 'patients' perceptions in adjunction to surgery. OHS assesses pain (6 items) and function (6 items) of the hip in relation to daily activities such as walking, dressing, sleeping etc.12 items with 5 categories of responses. Scores range from 0 to 4 (worst to best).
- Advantages:

  → Patient – Friendly

  → Useful predictor of early revision after THR or Bipolar hemiarthroplasty
- Disadvantages:

  → Double Barreled Questions

→ Lack of items concerning activities requiring a large angle of hip flexion, as well as use of walking aids and medication.

- Grading :

  0-19 → Worst, May indicate severe hip arthritis, requires some form of surgical intervention.

  20-29 → Fair, May indicate moderate to severe hip arthritis. Assessment by X-ray

  30- 39 → Good, May indicate mild to moderate hip arthritis. Non-surgical treatment, such as exercise, weight loss, and /or anti-inflammatory medication.

  40-48 → Excellent, May indicate satisfactory joint function. May not require any formal treatment.

MATERIALS & METHODS

MATERIALS and METHODS

Source of data:

Consist of 2 parts. Part I is a (prospective study) in which Patient's who undergone Bipolar hemiarthroplasty for fracture neck of femur at PSG Hospitals were included in the study after obtaining their consent during the period of December 2011 to June 2013.

Part II was a retrospective study where we took a data of patients who were operated earlier in our institute and had completed atleast 2 years of follow-up.

Method of data Collection :

By Convenient sampling method, the patients undergoing Bipolar hemiarthroplasty for fracture neck of femur were assessed radiologically for amount of inter-prosthetic joint motion during post-opeartive period.

Inclusion Criteria:

Patients who had undergone bipolar hemiarthroplasty for fracture neck of femur were included.

Exclusion Criteria:

- ➔ Bedridden patients
- ➔ Patients who have had post-operative infection,
- ➔ Patients who have developed myositis following bipolar hemiarthroplasty and
- ➔ Patients who have had Peri-prosthetic fractures

Implant used:

- For all patients Life ortho care Bipolar prosthesis was used (ISO – 13485 certified company). Implant made of 316 – Stainless steel. Femoral stem length is 150 mm, diameter – 8 mm. Outer head diameter varies from 37 to 53 mm with 2 mm increment. Inner prosthetic femoral head diameter was 26 mm and the lining between outer head and inner head is made of UHMWPE (Ultra High molecular Weight Polyethtylene). Neck shaft angle is 130 degrees. 2 types of prosthesis are available (Fixed only with collar, Modular with or without collar and Extra – long stem also available).
- No funding was received from the Implant company for the purpose of this study.

TYPES OF BIPOLAR PROSTHESIS USED IN OUR INSTITUTION. LEFT SIDE IS NORMAL FIXED BIPOLAR PROSTHESIS and RIGHT SIDE IS MODULAR BIPOLAR PROSTHESIS

P**art 1 - (Prospective study)** :

Pre-operative management : All patients who are undergoing bipolar hemiarthroplasty for fracture neck of femur are considered for the study after getting a written consent from them. All Patients were adequately worked up before surgery and all patients were taken up for surgery within 72 hours. Certain therapeutic measures such as Deep breathing exercises, Static Quadriceps exercises, ankle pumps were taught to the patient pre-operatively. A detailed history about the mode of injury and type of fracture were noted.

Surgical Procedure: All surgeries were performed on an elective basis using standard aseptic precautions, Surgery was performed under spinal or general anaesthesia. Patient was positioned laterally lying on the unaffected side. For all the patient's lateral approach (Hardinge approach) was used in our series.

Post-operative protocol: Throughout the post-operative period adequate care was taken to prevent abduction and external rrotation of the limb. All patients received Quads strengthening X's and mechanical DVT prophylaxis during immediate post-operative period. All patient's were started on Full weight bearing ambulation as tolerated by the patient. Once initial pain subsided specific X-rays were done to assess the inter-prosthetic joint (IPJ) and outer bearing movement was assessed during immediate post-op (24 to 48 hours) , at 6 weeks and after 6 months with operated hip in neutral and maximum abducted positions.

X-ray Technique:

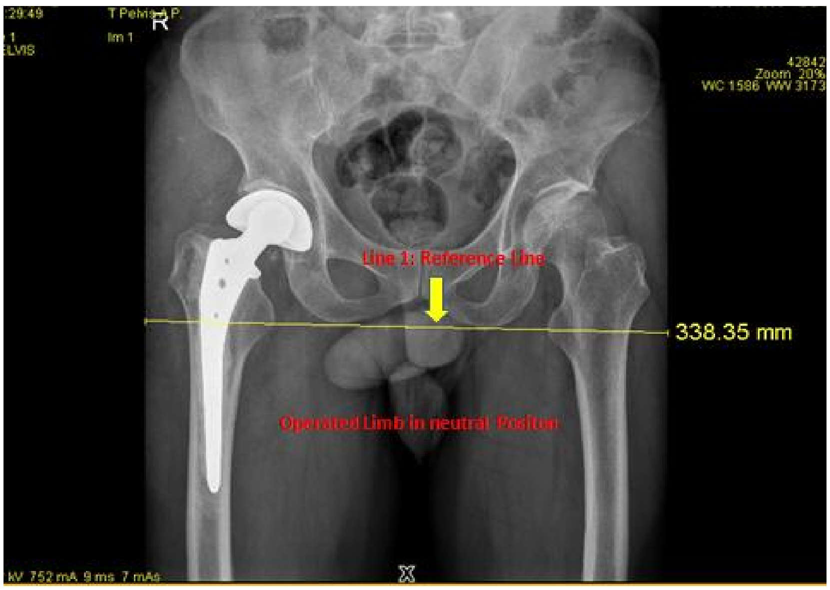
Two A.P x-rays of pelvis were taken. One with limbs in neutral position and neutral rotation and the other x-ray with affected limb in Maximum abduction are taken.

Radiological Assessment:

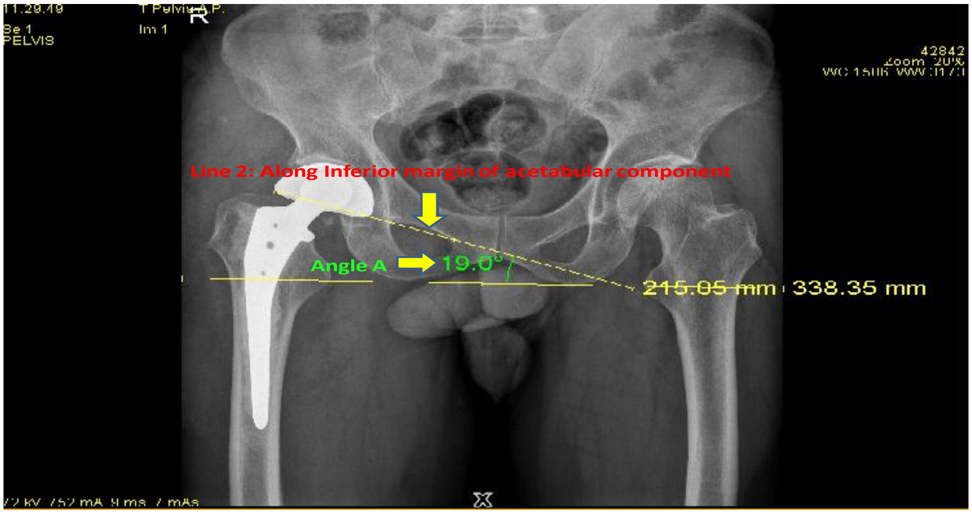
We followed the method of plain radiographs, as described by Bochner *et al*[43].

On the X-ray in the neutral position, 3 lines are drawn as follows:

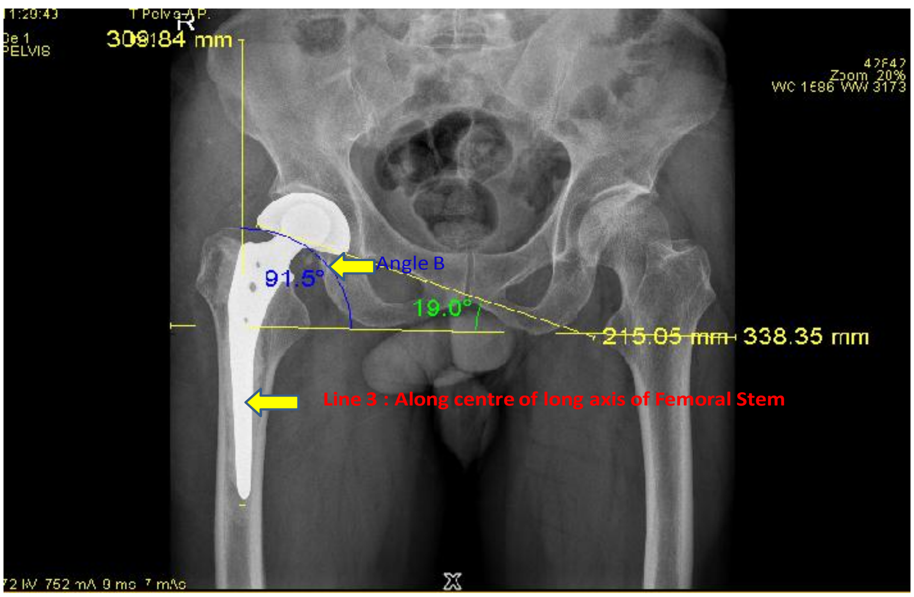
➔ Line 1: a line drawn tangential to the most inferior aspects of the ischial tuberosities which is used as a reference line.



➔ Line 2; drawn along the Inferior margin of acetabular component



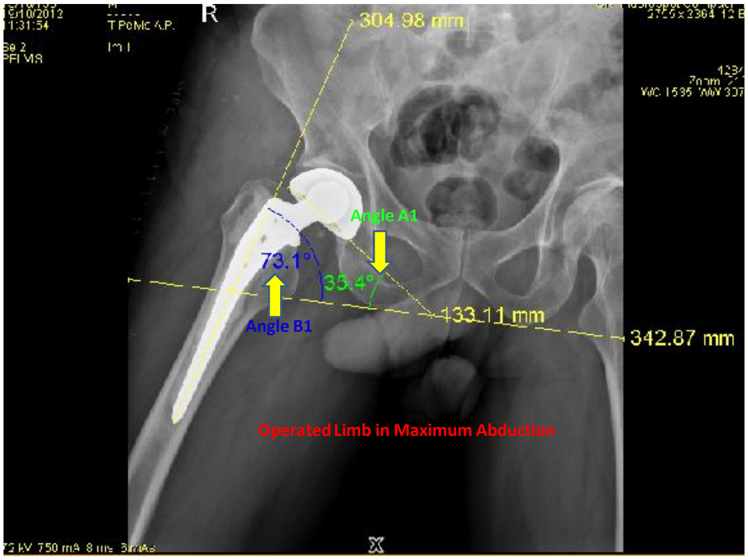
➔ Line 3 : Drawn along the centre of the long axis of femoral stem.



➔ Angle A was defined as the intersection of the line drawn from the inferior margin of acetabular component and the reference line (line of ischial tuberosities).

➔ Angle B was formed by the intersection of the ischial reference line with a line drawn along the center of the long axis of the femoral stem.

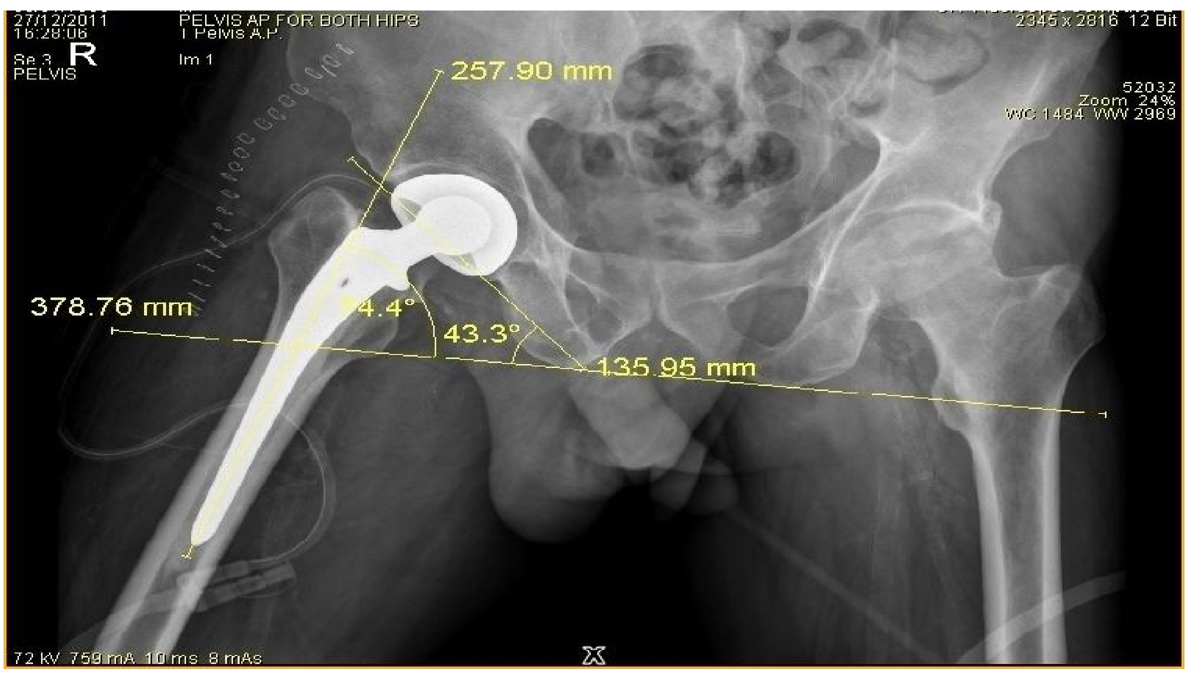
- The same exercise was repeated on the maximum abduction anteroposterior radiograph also and the angles are marked as A^1 and B^1.



- Now, B^2 is the difference between angle B and B^1 which represents the total amount of Hip abduction of the operated limb.
- A^2 is the difference between angle A and A^1 which represents the amount of motion taking place between the acetabular component and the acetabulum (Outer bearing interface).
- As we have 2 variables ie. (B2 – total amount of abduction, A2 – motion at the outer bearing interface),the difference between B^2 and A^2 represents the amount of abduction taking place at the inner bearing (Inter- Prosthetic joint movement).
- Thus the total amount of abduction, movement at outer bearing interface and movement at inter-prosthetic joint were calculated and tabulated for each patient at each follow-up.

Example:

X-ray of pelvis with both hips (neutral position) with Bipolar prosthesis on right side showing Angle A – 45.1 and Angle B – 86.4 degrees.



X-ray of pelvis with both hips (Abduction of operated hip) with Bipolar prosthesis on right side showing Angle A^{1} – 43.3 and Angle B^{1} – 74.4 degrees.

A = 45.1, B = 83.4, A1 = 43.3, B1 = 74.4 (DEGREES)

B2= 9 DEGREES (TOTAL ABDUCTION)

A2 = 1.8DEGREES (MOTION @ OUTER CUP)

B2-A2 = 7.2 DEGREES (INTER-PROSTHETIC JOINT MOTION)

A2 = 20 % (MOTION @ OUTER CUP)

B2 - A2 = 80 % (INTER-PROSTHETIC JOINT MOTION) .

At the end of 6 months follow-up, in addition to Radiological assessment Functional outcome was also assessed with Oxford hip score..

Part – 2 (Retrospective study):

Patients in this group who had already undergone Bipolar H.A and completed 2 years follow-up were reviewed. The x-rays were taken in the similar fashion as described above. Functional outcome assessment was done using Oxford hip score. The retrospective study helped us to assess IPJ motion at midterm follow-up.

Oxford Hip Score (OHS):

- It's useful to Assess the outcome after surgical procedures by measuring 'patients' perceptions in adjunction to surgery. OHS assesses pain (6 items) and function (6 items) of the hip in relation to daily activities such as walking, dressing, sleeping etc.12 items with 5 categories of responses. Scores range from 0 to 4 (worst to best).

- Grading :

0-19 → Worst, May indicate severe hip arthritis, requires some form of surgical intervention.

20-29 → Fair, May indicate moderate to severe hip arthritis. Assessment by X-ray

30- 39 → Good, May indicate mild to moderate hip arthritis. Non-surgical treatment, such as exercise, weight loss, and /or anti-inflammatory medication.

40-48 → Excellent, May indicate satisfactory joint function. May not require any formal treatment.

RESULTS

RESULTS

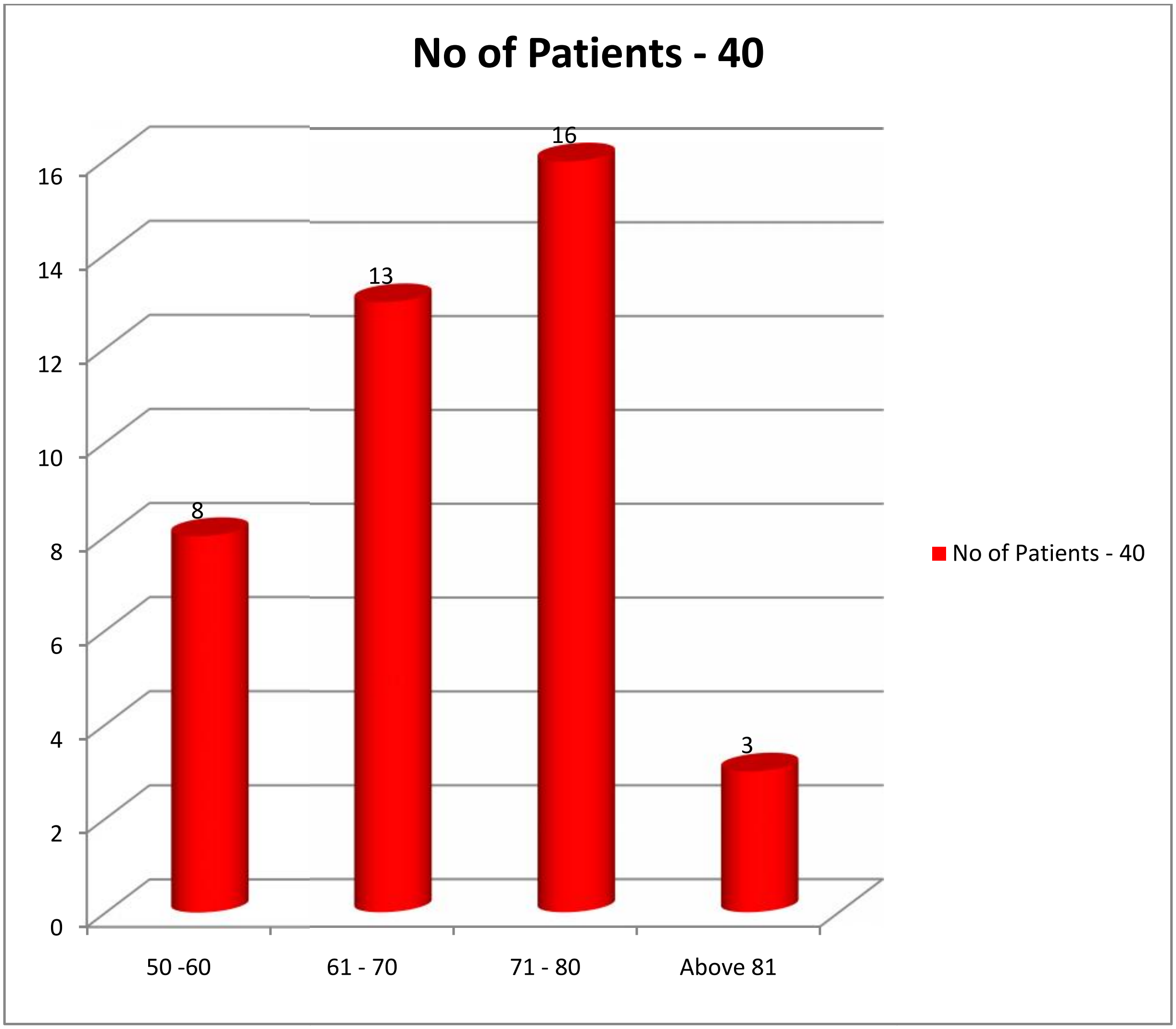
For Part I study 30 patients were included and for part II included 10 patients

Data was collected based on Radiological assessment and Oxford Hip score. The follow-up was at Immediate post-op, 6 weeks, 6 months and after 2 years (for retrospective study) and at the end of follow – up the functional outcome was assessed with Oxford Hip score.

TABLE – 1

AGE DISTRIBUTION

Age in Years	Frequency	Percent
50-60	8	20
60-70	13	32.5
70-80	16	40
Above 81	3	7.5
Total	40	100.0



GRAPH 1 : Age Distribution

Table 1 and Graph 1 shows distribution pattern of patient's. the average age was noted to be 69.3 years with age range between 52 to 86 years.

TABLE – 2

SEX DISTRIBUTION

Sex	Frequency	Percent
Male	25	62.5
Female	15	37.5
Total	40	100.0

Table 2 shows the sex distribution pattern. Most patients were found to be Men (62.5 %).

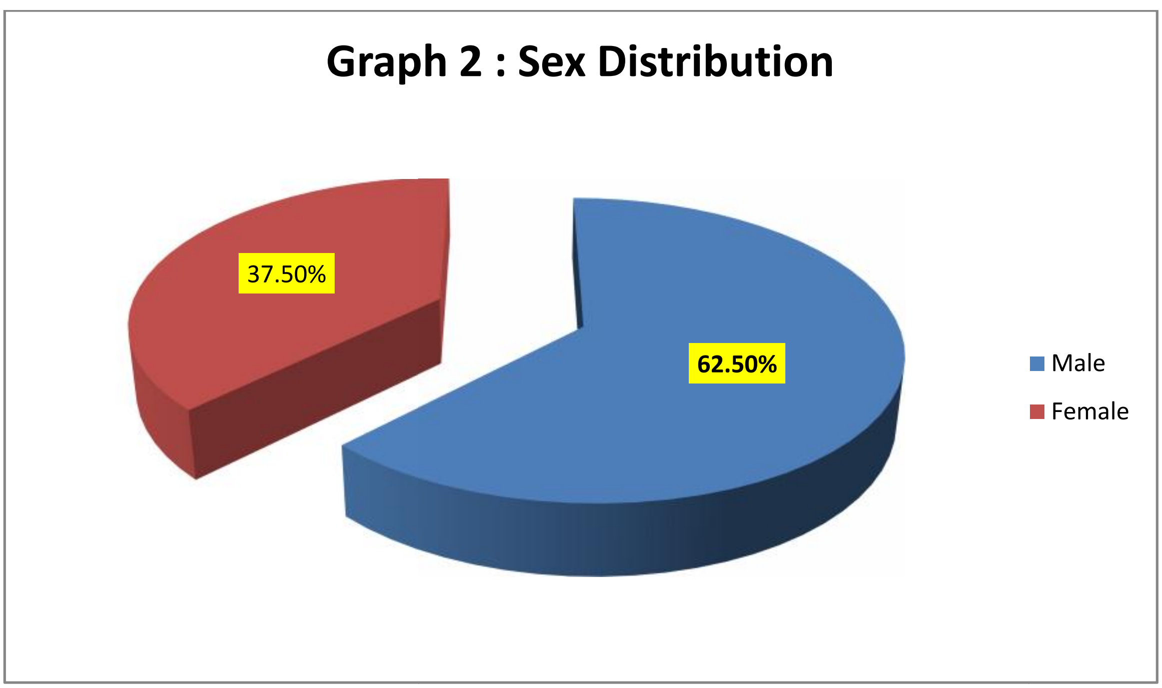


TABLE – 3

LATERALITY

Side	Frequency	Percent
Rt	24	60
Lt	16	40
Total	40	100.0

Table 3 : shows the laterality pattern of all the patients with right side being affected in 60%. In our study the right side is involved in 60 % cases. In various studies authors have reported 49 % involvement of left side and 51 % involvement of the right side [65].

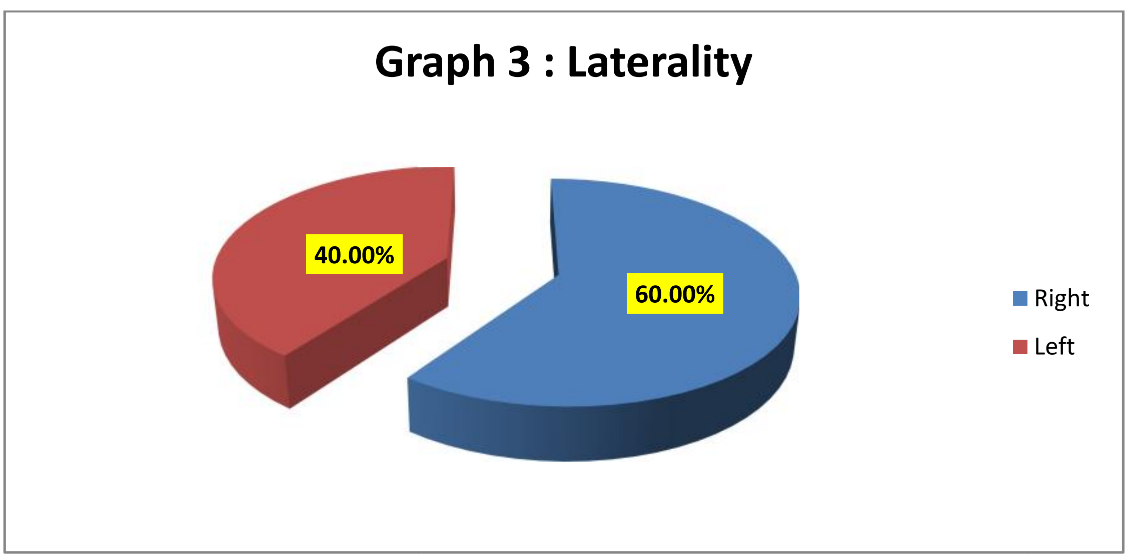


TABLE 4 – MODE OF INJURY

Mode of Injury	Frequency	Percent
Domestic Fall	27	90
RTA	3	10
Total	30	100.0

Table 4 shows Mode of injury pattern of 30 patients included in the prospective study which showed 90 % of injury due to Domestic Fall i.e Trivial trauma and rest of the 10% due to RTA. This was in accordance with majority of the series reported {Evarts (1973) [66], Fielding (1974) [67], Seth (1987) [68] etc… and several authors believe that the intra-capsular fracture are stress fractures through pathological bone secondary to osteoporosis or osteomalacia.

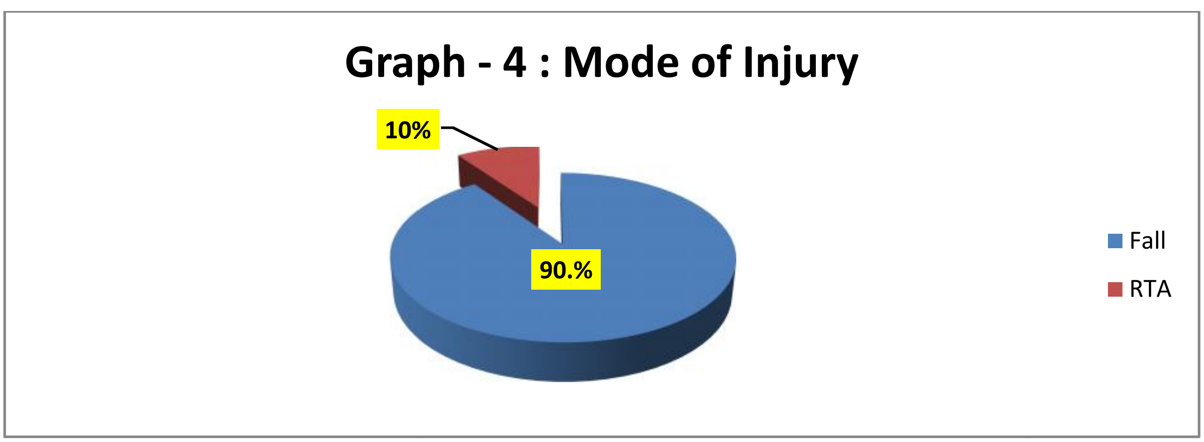


TABLE 5

FRACTURE PATTERN – ANATOMICAL CLASSIFICATION

Anatomical Types	Frequency	Percent
Basi - cervical	3	10
Trans -cervical	16	53.3
Sub-capital	11	36.7
Total	30	100.0

Table 5 shows Different fracture patterns based on anatomical classification in 30 patients of prospective study.

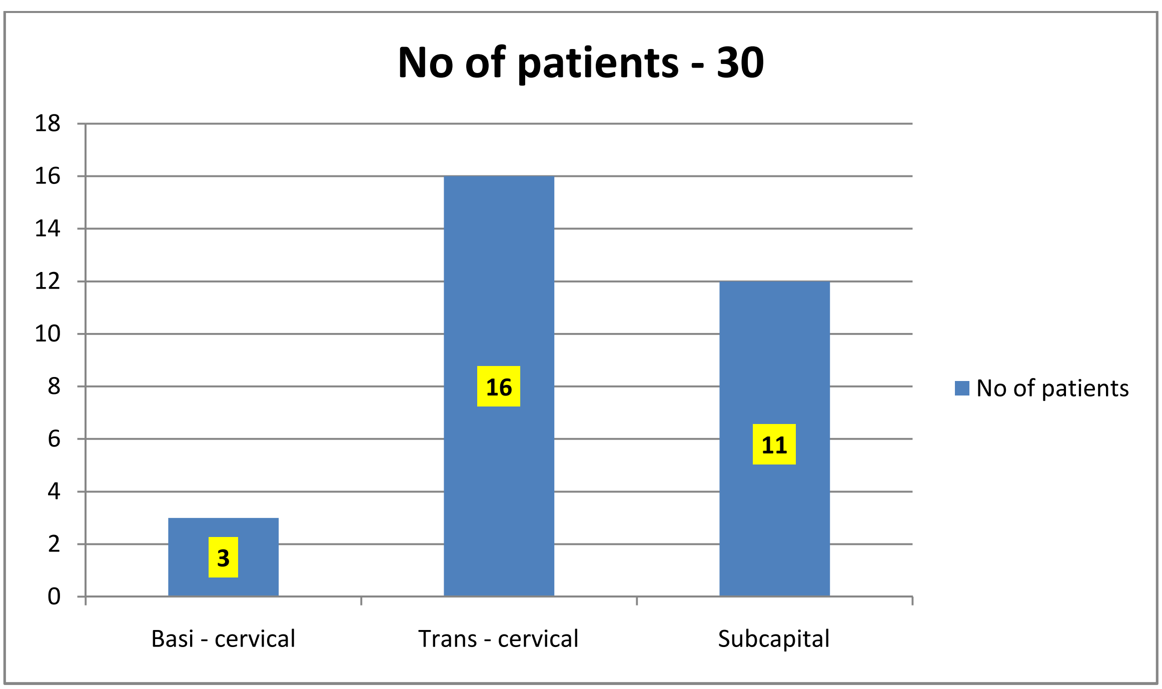


TABLE – 6

FRACTURE PATTERN – GARDEN'S CLASSIFIATION

Garden's	Frequency	Percent
G II	3	10
G III	10	33.3
G IV	17	56.7
Total	30	100.0

Table 6 shows Fracture pattern according to Garden's Classification in 30 patients of prospective study, Type IV Garden's was found to be in 56. % of the cases.

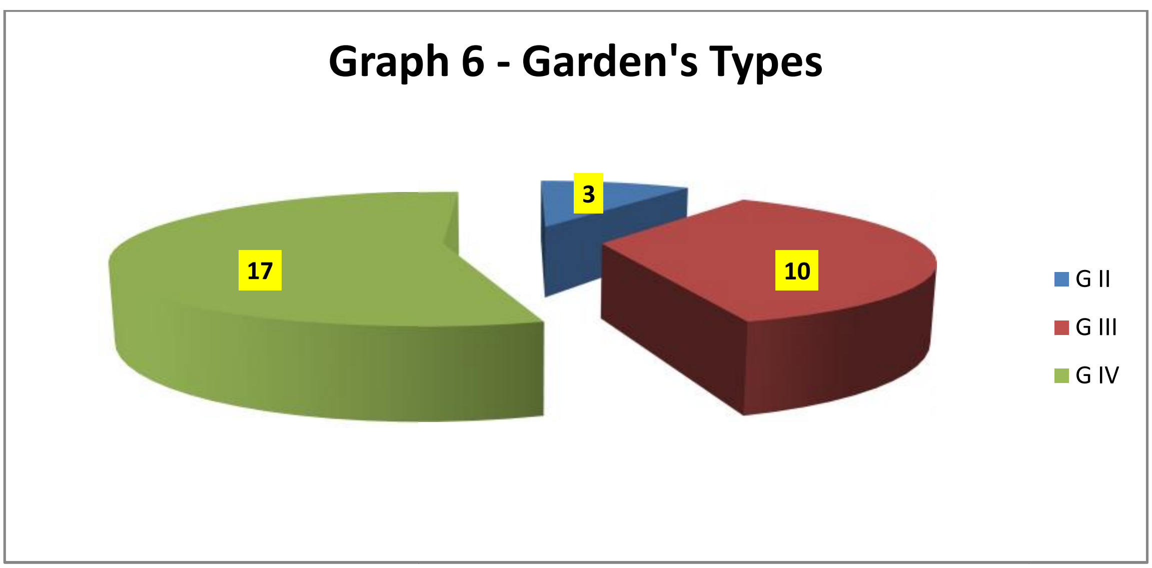


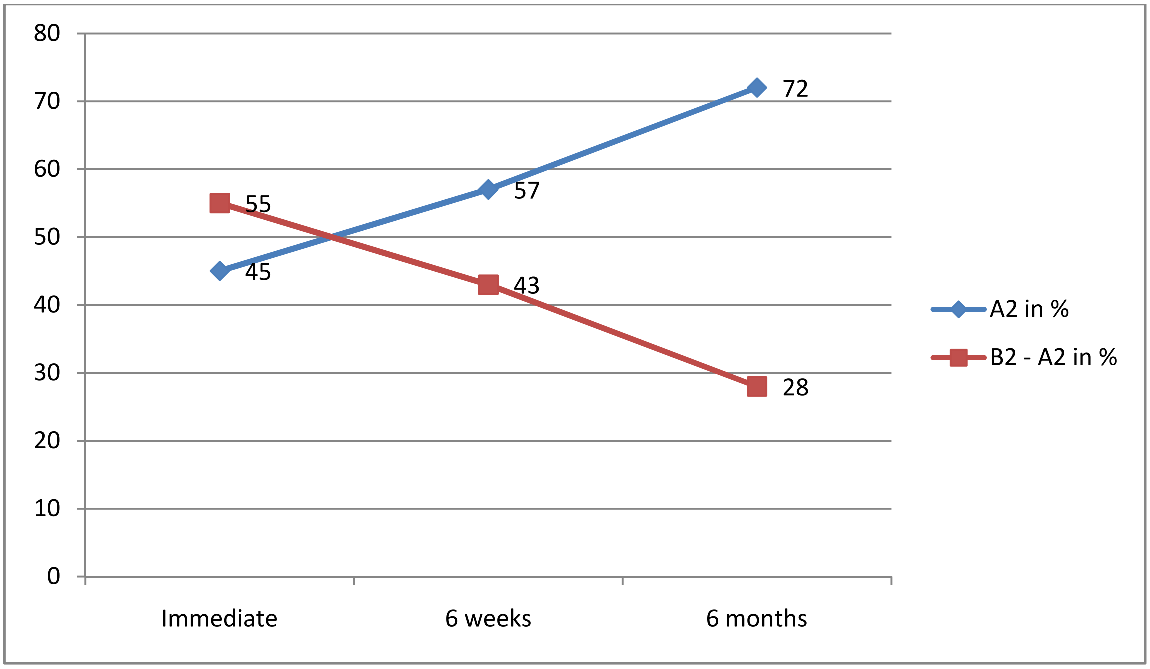
TABLE 7

RADIOLOGICALLY ASSESSED TOTAL ABDUCTION, OUTER CUP MOTION and INTER – PROSTHETIC JOINT MOTION

Duration of Follow up	No of Patient's	Mean B^2 (in degrees)	Mean A^2 (in degrees)	Mean $B^2 – A^2$ (in degrees)	Mean A^2 (in %)	Mean $B^2 - A^2$ (in %)
Immediate Post-op	30	18	8	10	45	55
6 weeks	28	23	13	10	57	43
6 months	30	25	18	7	72	28

B^2 – represents Amount of Total abduction, A^2 – represents amount of movement between the outer cup and the acetabulum, $B^2 – A^2$ represents amount of IPJ motion.

Table 7 depicts the progressive decrease in the IPJ movement over a period of 6 months of 30 patients. During follow – up only 28 patients turned up at 6 weeks, but as the remaining 2 patients came for the final follow – up they are included in the study.



Graph depicting change in the movement at IPJ and that between the acetabulum and the prosthesis, expressed as percentage of total movement, has been plotted against time.

TABLE – 8

BINOMINAL TEST

IPJ Motion over a time period		Category	N	Observed Prop.	Test Prop.	Asymp. Sig. (2-tailed)
B2-A2 6 Immediate	Group 1	More than 25%	25	.84	.50	.000(a)
	Group 2	Less than 25%	5	.16		
	Total		30	1.00		
B2-A2 6 Weeks	Group 1	More than 25%	27	.96	.50	.000(a)
	Group 2	Less than 25%	1	.04		
	Total		28	1.00		
B2-A2 6 Months	Group 1	More than 25%	20	.67	.50	.099(a)
	Group 2	Less than 25%	10	.33		
	Total		30	1.00		

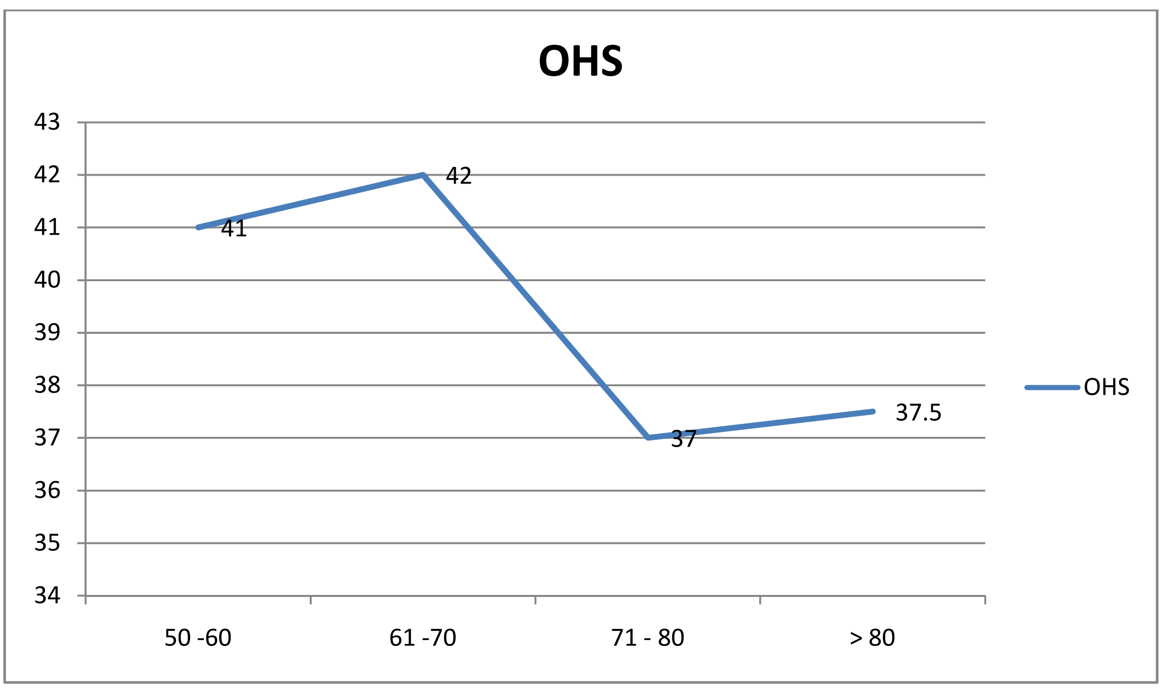
The Binominal Test (Z test) showed the the value of significance of B2 – A2 at Immediate Post-op and at 6 weeks post-operative period, but not significant at 6 months post-operative period. So from this data we could infer that there is significant movement taking place at the inter-prosthetic joint upto 6 weeks, but as the time progresses the movement at the joint interface is not very significant. For the ease of data assessment the patient group was splitted into IJP > 25 % - Group I and IPJ < 25 % - Group II.

TABLE 9

OXFORD HIP SCORE Vs AGE OF THE PATIENT

OHS OF PATIENT'S OF DIFFERENT AGE GROPUS	NO OF PATIENTS	MEAN OHS	STD. DEVIATION	MINIMUM OHS	MAXIMUM OHS
50-60	7	41.5714	6.72947	32.00	48.00
60-70	9	42.0000	2.73861	39.00	48.00
70-80	12	37.0833	6.88157	26.00	46.00
ABOVE 80	2	37.5000	13.00000	36.00	39.00
TOTAL	30	38.9355	7.19692	26.00	48.00

Table 9 depicts the Oxford Hip score of different age gropus in involving 30 patients of prospective study group, showing decrease in OHS as the age increases. But the decrease in OHS with increasing age group was not statistically significant (P = 0.062 ie > 0.05).



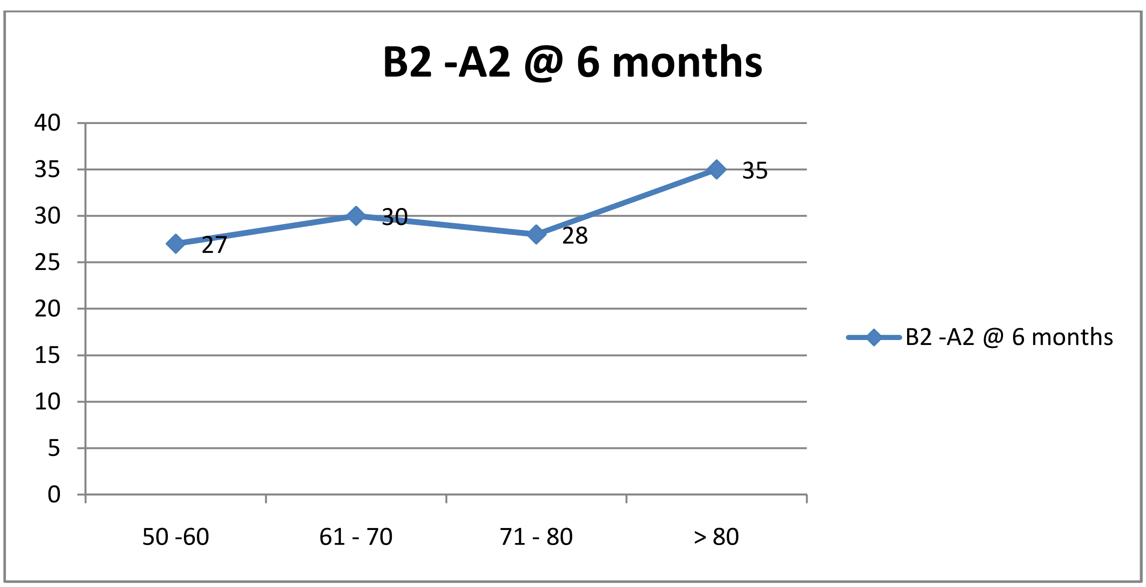
This graph predicts the decline in the OHS as the age progresses, except for the initial part.

TABLE 10

IPJ MOTION AT 6 MONTHS Vs AGE

AGE GROUP	No OF PATIENTS	MEAN B^2-A^2	STD. DEVIATION	MIN	MAX
50-60	7	27.8571	8.31522	14.00	38.00
60-70	9	30.1111	5.30199	25.00	39.00
70-80	12	28.6667	6.31497	18.00	38.00
Above 80	2	35.5000	.70711	35.00	36.00
Total	30	29.3667	6.38146	14.00	39.00

Table 10 shows the IPJ motion at end of 6 months in various age groups in prospective study of 31 patients. On data analysis there was no statistical significance between the IPJ motion and various age groups ($P = 0.495 > 0.05$). Though the IPJ motion seems to be higher in patients above 80 years, the sample size for the particular age group was not significant.



This graph demonstrates the relation of $B^2 - A^2$ in various age groups.

TABLE 11

OXFORD HIP SCORE Vs SEX DISTRIBUTION

Sex Distribution	No Of Patients	Mean OHS	Std. Deviation	Minimum	Maximum
Male	18	38.5263	7.99561	28.00	48.00
Female	12	39.5833	5.99179	26.00	48.00
Total	30	38.9355	7.19692	16.00	48.00

Table 11 shows comparison of OHS in different genders in the prospective study. This table predicts the females to have better OHS compared to males, but data analysis showed that there's no statistical difference in OHS between the 2 different genders ($P = 0.697 > 0.05$).

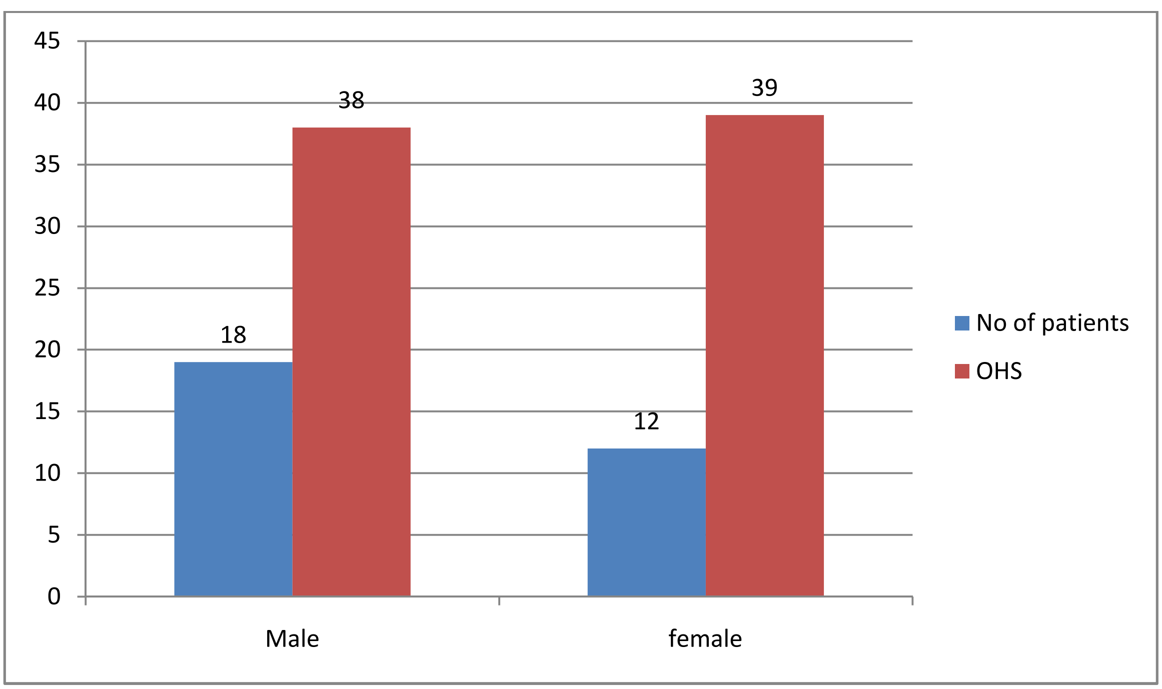


TABLE 12

IPJ MOTION at 6 MONTHS Vs SEX DISTRIBUTION

Sex distribution	No of patients	Mean B2-A2	Std. Deviation	Min	Max
Male	18	29.3333	6.95363	14.00	39.00
Female	12	29.4167	5.71216	20.00	38.00
Total	30	29.3667	6.38146	14.00	39.00

Table 12 depicts the comparison of B2 – A2 at 6 months against the gender in prospective study of 30 patients. The IPJ motion was found to be almost the same in both females and males. There was also a statistical difference between the 2 groups in relation to IPJ motion (P = 0.973 > 0.05).

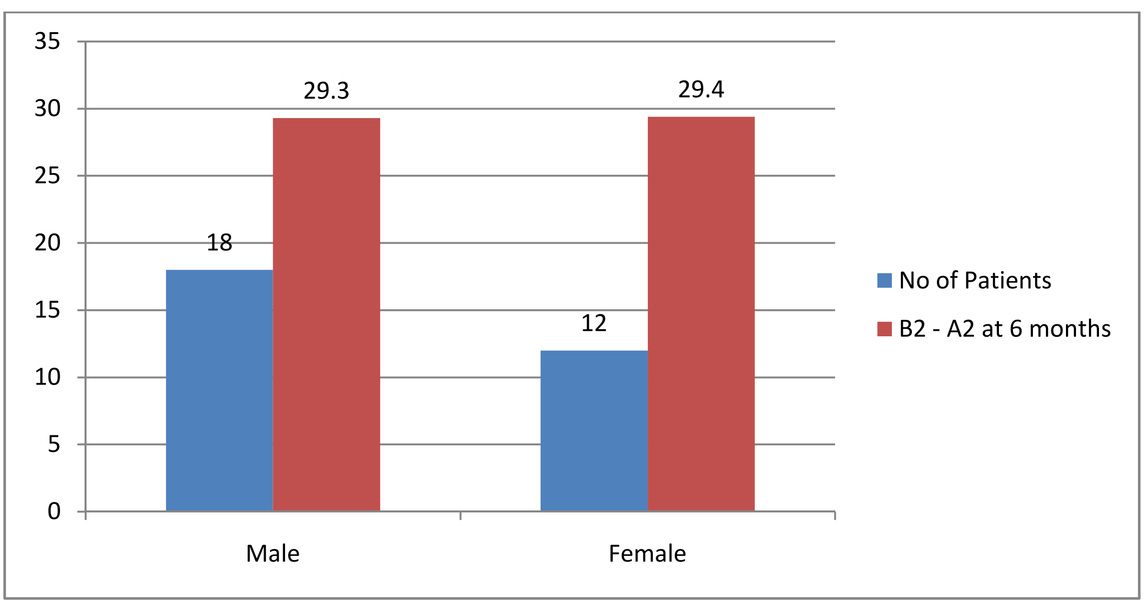


TABLE 13

IPJ MOTION AT 6 MONTHS Vs OXFORD HIP SCORE

B2 – A2 AT 6 MONTHS	NO OF PATIENTS	Mean OHS	Std. Deviation	Minimum OHS	Maximum OHS
More than 25%	20	42.7000	3.21346	38.00	48.00
Less than 25%	10	33.7000	5.51866	26.00	41.00
Total	30	39.7000	5.90237	26.00	48.00

Table 13 depicts the comparison of IPJ motion at 6 months with Oxford Hip Score in prospective study of 30 patients. IPJ motion of the patients was divided into 2 groups for the ease of data analysis (Group I – IPJ motion > 25 %, Group II – IPJ motion < 25 %). Based on our data analysis the mean OHS was statistically significant in patients with IPJ motion > 25 % (Mean OHS – 42.7), (P = 0.00 < 0.05).

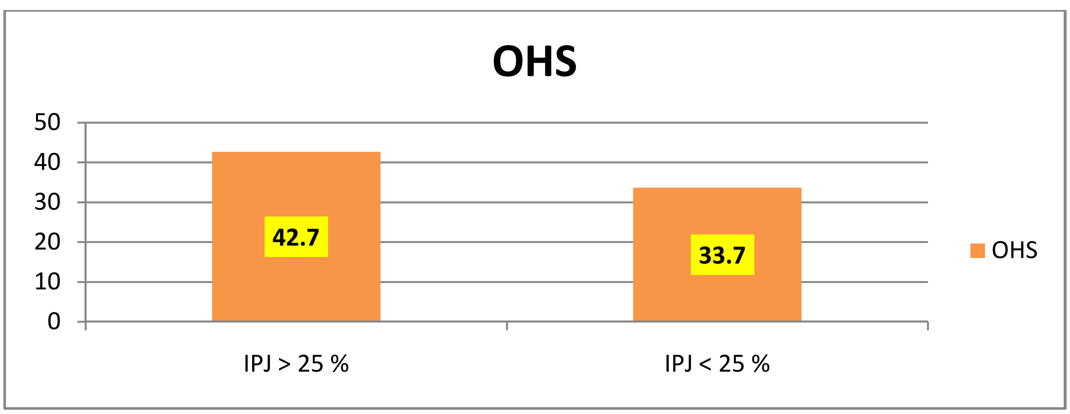


TABLE – 14

RETROSPECTIVE STUDY IPJ MOTION

No of Patients	Mean B2 – A2	Std. Deviation	Min	Max
10	31.0000	10.36018	15	50

Table 14 shows the Mean IPJ motion of 31 degrees in the retrospective study.

TABLE – 15

RETROSPECTIVE STUDY – OXFORD HIP SCORE

No of Patients	**Mean OHS**	**Min**	**Max**
10	**38.1**	**28**	**44**

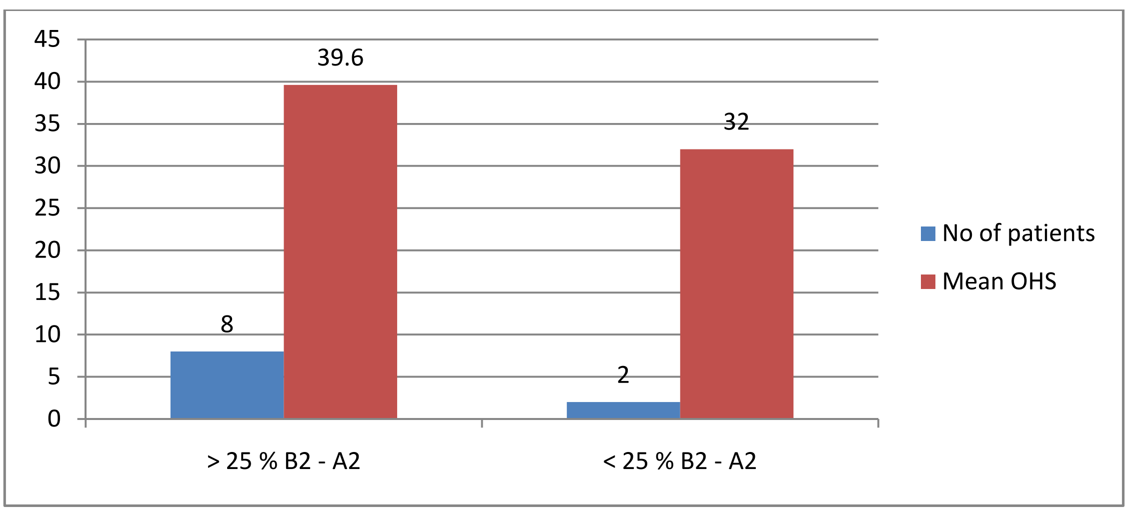
Table 15 shows Oxford hip score of retrospective study of 10 patients with mean OHS – 38.1.

TABLE – 16

RETROSPECTIVE STUDY – IPJ MOTION IN % Vs OHS

B2 – A2 at time of follow up	No of patients	Mean OHS	Min OHS	Max OHS
>25 %	8	39.625	35	44
<25 %	2	32	28	36
Total	10	38.1	28	44

Table 16 shows comparison between the IPJ motion and OHS in Retrospective Study. Since the sample size is small in retrospective study this data was not compared with the data in the Prospective study. For the current retrospective data the analysis was not statistically significant.



DISCUSSION

DISCUSSION

The basic advantage of the Bipolar prosthesis over conventional unipolar prosthesis is movement at the two interfaces ie. between the prosthetic inner femoral head and polyethyelene liner and between acetabulum and the outer head. It was proposed that the complications like acetabular erosions would be delayed or prevented [69] by reducing wear due to sliding motion in the acetabular socket. The high molecular weight polyethylene (HMWPE) articulation also absorbs some of the impact forces during gait. This advantage of Bipolar over unipolar prosthesis has been accepted by many studies[69 - 71], but there have been some reports in the literature that cast doubt on the continuity of inter-prosthetic movement in a bipolar prosthesis over time. Various radiographic studies have been done in which the prosthesis was imaged in various non-weight-bearing and static weight-bearing positions to estimate the fraction of movement that is occurring at the inter-prosthetic joint in a bipolar prosthesis. Phillips[63] used radiograph in supine position, first in neutral and then in maximum abduction and adduction. Verberne[64] used image intensifier to do radiological examination.

In this context we undertook the present study of evaluating the IPJ motion radiologically over a period of time at 6 months and at the end of 2 years. We had also tried to co-relate the amount of IPJ movement to Functional outcome to assess whether there's any improvement in the quality of life in patient's with good IPJ motion.

We followed the method of plain radiographs, as described by Bochner *et al*[43]. In our series the amount of IPJ movement was 55 % during immediate post-op, 43 % during 6weeks & 28 % at the end of 6 months. The mean Inter – prosthetic joint movement at end of 2 years follow – up was 31 % for patients in the retrospective group. So at the end of 6 months 66 % of the patients had > 25% of Inter prosthetic joint movement in our prospective study and 80% had > 25 % in the retrospective study. However we are not analyzing the same group of patients in the prospective and retrospective study & the sample size of retrospective study is small. This could have probably resulted in higher inter – prosthetic joint movement at the end of 2 years.

Drinker and Murray[72] reported that although some inner motion occurred in most implants, it was less than predicted. Philips TW (1987) had done a study on Fluroscopic movement in 100 patients who had undergone Bateman Bipolar arthroplasty. Out of these 100 patients Group I had 76 patients with arthritis of hip and Group II had 24 patients with neck of femur fractures. In 80 % of group I patients, the prosthesis retained Bipolar function at the end of 4 years follow-up study as compared to only 25 % of group II patients retained the bipolar functioning of the prosthesis [63].

Verbene G.H.M (1983), did a radiological study of movements of two components in Variokopf prosthesis in 20 patients with fracture neck of femur during Immediate, 1 month and 3 months post-operative period. He observed that the IPJ lost mobility and at 3 months it became almost completely stiff with inter-prosthetic joint motion of only 16.9 % being retained.

Bochner RM , in a study 26 patients with Bateman's Prosthesis who were assessed radiologically for inter-prosthetic joint motion, concluded that Bipolar function was retained at the end of 4 years and the motion was shared between both the joint interfaces [43]. In their study the inter-prosthetic joint motion at 6 months was 19 %.

In a study conducted Anil kumar rai, from Banaras hindu university, varanasi, india during the period march 2003 to january 2011 treated with BHU bicentric bipolar prosthesis, showed that in cases of fracture neck of femur, the percentage of total abduction occurring at the interprosthetic joint at 3 months was 33.74% (mean value of all the patients), which fell to 25.66% at 1.5 years and remained stationary till 6 years. So they concluded that some amount of IPJ motion is still preserved at the time of their mid-term follow-up of 6 years. Higher Inter-prosthetic joint motion was observed in the arthritic group as compared to fracture group. This could be explained possibly due to friction phenomenon.

The results of our study regarding the Inter – prosthetic joint movement was comaparable to other studies in literature. Verbene et al. showed only 16.9 % inter-prosthetic Joint movement at the end of 3 months in 20 patients & Bochner et al. showed 19 % movement at the end of 6 months in 18 patients. Our study had better inter-prosthetic joint movement of 28 % at end 6 months. This result probably could have been due to lower sample size of the above 2 studies.

Factors Influencing the Inter – prosthetic Joint movement

1. Condition of the Acetabulum: In patients with normal articular cartilage of acetabulum, the outer cup probably slides more when compared patients with arthritis. This can probably due to friction at which the primary movement occurs in IPJ . Only at the terminal range of movements prosthetic femoral head impinges on the neck leading to movement of the outer cup.

2. The Inner femoral head size used by Verbene et al was 32 mm which could have probably decreased the IPJ motion, when compared to Bochner and Philips et al where they used 22 mm inner femoral head. In the study done by Philips TW they had suggested that lower the femoral prosthetic head size, then lower will be the friction between the Polyethylene liner & femoral head & decreased stress on outer metal cup, which will result in lower acetabular erosions.
3. In previous studies they had used prosthesis with High density polyethylene which is prone for formation of wear debris over time, which could have possibly played a role in decreasing the IPJ motion. The wear debris formed from UHMWPE is much lower than the HDPE used in those days which could have contributed to better IPJ movement.

Since in our study we had used Bipolar prosthesis consisting of UHMWPE liner & optimum size prosthetic Femoral Head, our patients had better inter-prosthetic joint movement when compared with Verberne et al. & Bochner et al. we also assessed the age of the patient co – relating with Inter –prosthetic joint movement, but we did not find any statistical signifance.

AGE DISTRIBUTION:

Name of the Study	Age range in years	Mean age in years
Lestrange (1990) [70]	**53 – 97**	**79.67**
BUMC (1977) [73]	**53 – 97**	**77.7**
Gilberty (1983)	**32 – 102**	**72.5**
Cornell (1998) [74]	**67 – 97**	**78**
Raja (2003) [75]	**65 – 95**	**82.4**
Our study	**52 – 86**	**69.3**

Our sample study is less when compared to western literature but is comparable to Indian studies.

ASSESSMENT OF FUNCTIONAL OUTCOME USING OXFORD HIP SCORE AND IT'S CO-RELATION WITH IPJ MOTION

Various criteria were used to assess the functional results following Bipolar hemiarthroplasty. How best the patient is returned to the pre-fracture status has been the main criteria. In India our customs demand Squatting and sitting cross leged without difficulty. To achieve this patient should have good range of flexion, abduction, adduction and external roation at the hip and full flexion at the knee. Our final results at 6 months after bipolar hemiarthroplasty in our series were analyzed using Oxford Hip Score. The results were compared with the available western and Indian series where Bipolar hemiarthroplasty was done for neck of femur patients.

Investigator	No of patients	Excellent	Good	Fair	Poor
Hinchey (1976)	225	52.4	20.4	10.7	16.4
Saxena and saraf (1978)[76]	82	46.1	44.8	6.5	2.6
Mukeherjee and Puri (1986)	55	29	49	18	4
Bavadekar and Manelkar (1987)	328	60		30	10
Arvade (1987)	104	70		16	14
Our series (2012 -13)	40	56	32	10	2

This table depicts the percentage of functional results following bipolar arthroplasty done for fracture neck of femur.

The difference between excellent and good results are minimal and therefore they can be gropued together as satisfactory results. In the series above Hinchey had 72.8 % , Saxena [76] 90.9%, Mukerjee and Puri 78 %, Bavedekar 60 % satisfactory results were achieved. In out series satisfactory results were achieved in 88 % of our cases. Only 2 % of the patients had poor results due to moderate /marked pain.

We found that there was no stastistical significance in between the age, sex Vs OHS. However we were able to analyse the relation between the IPJ motion and OHS. We found that there was significant increase in OHS in patients with IPJ motion of more than 25 %. So we conclude that more the amount of IPJ motion preserved better will be the functional outcome in patients with Bipolar arthroplasty done for femoral neck fractures.

CONCLUSION

CONCLUSION

With this study we found that for effective functioning of bipolar prosthesis IPJ movement remains a vital cog in the success of the bipolar prosthesis. In this study we conclude that:

1. There is good amount Inter-prosthetic joint movement of Bipolar prosthesis at short – term and mid - term follow-up.
2. The functional outcome is also good when Inter-prosthetic joint movement is more than 25% .

Limitations of the Study:

- ➔ In this study the patients in the prospective and retrospective are not the same. And hence the results show a trend rather than being specific.
- ➔ Sample size is small
- ➔ Long term studies are required

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ANNEXURE

ANNEXURE

RADIOLOGICAL ASSESSMENT OF INTER PROSTHETIC JOINT MOTION IN BIPOLAR

Patient No		IMMEDIATE						6 WEEKS						6 MONTHS										
		IN DEGREES			IN PERCENTAGE			IN DEGREES			IN PERCENTAGE			IN DEGREES			IN PERCENTAGE			Fracture classication				
		B2 - TOTAL ABDUCTION	A2-MOTION @ OUTTER CUP	B2-A2 - MOTION @ INTER PROSTHETIC JOINT	A2%	B2-A2%		B2 - TOTAL ABDUCTION	A2-MOTION @ OUTTER CUP	B2-A2 - MOTION @ INTER PROSTHETIC JOINT	A2%	B2-A2%		B2 - TOTAL ABDUCTION	A2-MOTION @ OUTTER CUP	B2-A2 - MOTION @ INTER PROSTHETIC JOINT	A2%	B2-A2%	Age / sex	Anatomical	Garden's	Side	Mxn of Injur	OHS
1	xray	24.3	6	18.3	25	75	xray	19.4	11.2	8.2	58	42	XRAY	25	16.1	8.9	64	36	64/M	Basi	G III	Rt	Fall	44
2	x-ray	8.8	5.8	3	66	34	x-ray	22	16	6	73	27	x-ray	28	21	7	75	25	60/M	Trans	G IV	Lt	Fall	38
3	x-ray	9	1.8	7.2	20	80	x-ray	20	9	11	45	55	x-ray	20	15.6	4.4	78	22	52/M	Trans	G III	Rt	Fall	32
4	x-ray	18.9	8.5	10.4	45	55	x-ray	25	17	8	68	32	x-ray	29	21	8	72	28	65/F	Trans	G IV	Rt	Fall	41
5	x-ray	18.2	5.2	13	29	71	x-ray	20.6	10.3	10.3	50	50	x-ray	21.4	17.5	3.9	82	18	74/M	Trans	G IV	Rt	RTA	28
6	x-ray	18.6	4.3	14.3	23	77	x-ray	21.6	13.2	8.4	61	39	x-ray	25	17	8	68	32	73/M	Trans	G II	Lt	Fall	46
7	x-ray	19.8	10.9	8.9	55	45	x-ray	25	17	8	68	32	x-ray	26	20.8	5.2	80	20	76/F	S.C	G IV	Rt	Fall	31
8	x-ray	18.9	8.5	10.4	45	55	x-ray	20	11.3	8.7	56	44	x-ray	23.5	16.2	7.3	69	31	76/F	S.C	G IV	Rt	Fall	40
9	x-ray	19.4	18	1.4	93	7	x-ray			0	#DIV/0!	#DIV/0!	x-ray	19	11.7	7.3	62	38	60/F	S.C	G IV	Lt	Fall	46
10	x-ray	14	13.4	0.6	96	4	x-ray	22	13	9	59	41	x-ray	26	18	8	69	31	72/F	S.C	G IV	Lt	Fall	42
11	x-ray	14.9	5.4	9.5	36	64	x-ray	26	15	11	58	42	x-ray	28	21	7	75	25	65/F	S.C	G IV	Lt	Fall	39
12	x-ray	21.4	17.5	3.9	82	18	x-ray	23	15.3	7.7	67	33	x-ray	30	21	9	70	30	62/M	Basi	G III	Rt	Fall	48
13	x-ray	23.6	1.7	21.9	7	93	x-ray	25	17	8	68	32	x-ray	29	21	8	72	28	76/F	Trans	G II	Rt	Fall	38
14	x-ray	21.4	20.1	1.3	94	6	x-ray	22	16	6	73	27	x-ray	28.2	21.2	7	75	25	66/M	S.C	G IV	Lt	Fall	40
15	x-ray	8.7	6	2.7	69	31	x-ray			0	#DIV/0!	#DIV/0!	x-ray	20	15.4	4.6	77	23	73/F	S.C	G IV	Lt	Fall	26
17	x-ray	13	6.2	6.8	48	52	x-ray	23	16	7	75	25	x-ray	26	20	6	77	23	80/M	Trans	G III	Lt	RTA	28
18	x-ray	11.6	7.1	4.5	61	39	x-ray	22	16	6	73	27	x-ray	21.5	18.4	3.1	86	14	60/M	Trans	G IV	Rt	Fall	34
19	x-ray	24.3	6	18.3	25	75	x-ray	19.4	11.2	8.2	58	42	x-ray	25.3	16.1	9.2	64	36	82/M	S.C	G III	Rt	Fall	39
20	x-ray	23	6.2	16.8	27	73	x-ray	26.2	11.2	15	43	57	x-ray	28.2	17.2	11	61	39	67/M	Trans	G IV	Lt	Fall	43
21	x-ray	20	5	15	25	75	x-ray	25	10	15	40	60	x-ray	28	19	9	68	32	80/M	Trans	G III	Lt	Fall	40
22	x-ray	20	8.2	11.8	41	59	x-ray	24	13.2	10.8	55	45	x-ray	22.1	16.5	5.6	75	25	61/F	Basi	G IV	Rt	Fall	41
23	x-ray	18.6	8.1	10.5	44	56	x-ray	26.4	14.4	12	55	45	x-ray	25	17	8	68	32	73/M	S.C	G IV	Lt	Fall	42
24	x-ray	18.6	4.3	14.3	23	77	x-ray	21.6	13.2	8.4	61	39	x-ray	26	17	9	65	35	86/M	Trans	G III	Lt	Fall	38
25	x-ray	9	1.8	7.2	20	80	x-ray	20	9	11	45	55	x-ray	22	15.6	6.4	71	29	52/M	Trans	G IV	Rt	Fall	46
26	x-ray	19.8	10.9	8.9	55	45	x-ray	24.2	11.8	12.4	49	51	x-ray	26.2	17.1	9.1	65	35	64/F	Trans	G IV	Rt	Fall	40
27	x-ray	21.4	17.5	3.9	82	18	x-ray	23	15.3	7.7	67	33	x-ray	29	21	8	72	28	68/M	Trans	G II	Rt	Fall	42
28	x-ray	18.9	8.5	10.4	45	55	x-ray	24	13	11	54	46	x-ray	21	13.1	7.9	62	38	75/F	Trans	G IV	Rt	Fall	43
29	x-ray	20	5	15	25	75	x-ray	25	10	15	40	60	x-ray	28	18	10	64	36	60/M	Trans	G III	Lt	Fall	47
30	x-ray	18.9	8.5	10.4	45	55	x-ray	20	12.2	7.8	61	39	x-ray	23.6	16.3	7.3	69	31	58/F	S.C	G III	Rt	RTA	48
31	x-ray	24.3	6	18.3	25	75	x-ray	19.4	11.2	8.2	58	42	x-ray	25.3	16.1	9.2	64	36	75/M	S.C	G III	Rt	Fall	41

MASTER CHART OF PROSPECTIVE STUDY

SNO	PATIENT No	B2 (DEGREES)	A2 (DEGREES)	B2 – A2 (DEGREES)	A2 %	B2 – A2 %	X-ray
1.	32	21.5	18.4	3.1	85	15	X-ray
2	33	30	21	9	70	30	X-ray
3	34	28	19	9	68	32	X-ray
4	35	20.6	10.3	10.3	50	50	X-ray
5	36	22	16	6	73	27	X-ray
6	37	19.4	11.2	8.2	58	42	X-ray
7	38	22	16	6	73	27	X-ray
8	39	20	16	4	80	20	X-ray
9	40	25	18	7	72	28	X-ray
10	41	12	7.3	4.7	61	39	X-ray

CHART SHOWING TOTAL ABDUCTION, OUTER BEARING MOTION and INTER – PROSTHETIC JOINT MOTION IN RETROSPECTIVE STUDY

Sno	Patient No	Age	Sex	B2 – A2	OHS
1	**32**	72	M	**15**	28
2	**33**	62	F	**30**	44
3	**34**	86	M	**32**	38
4	**35**	78	M	**50**	40
5	**36**	68	M	**27**	37
6	**37**	76	M	**42**	42
7	**38**	78	M	**27**	35
8	**39**	64	M	**20**	36
9	**40**	68	F	**28**	42
10	**41**	78	F	**39**	39

CHART SHOWING AGE, SEX and INTER – PROSTHETIC JOINT MOTION and OXFORD HIP SOCRE